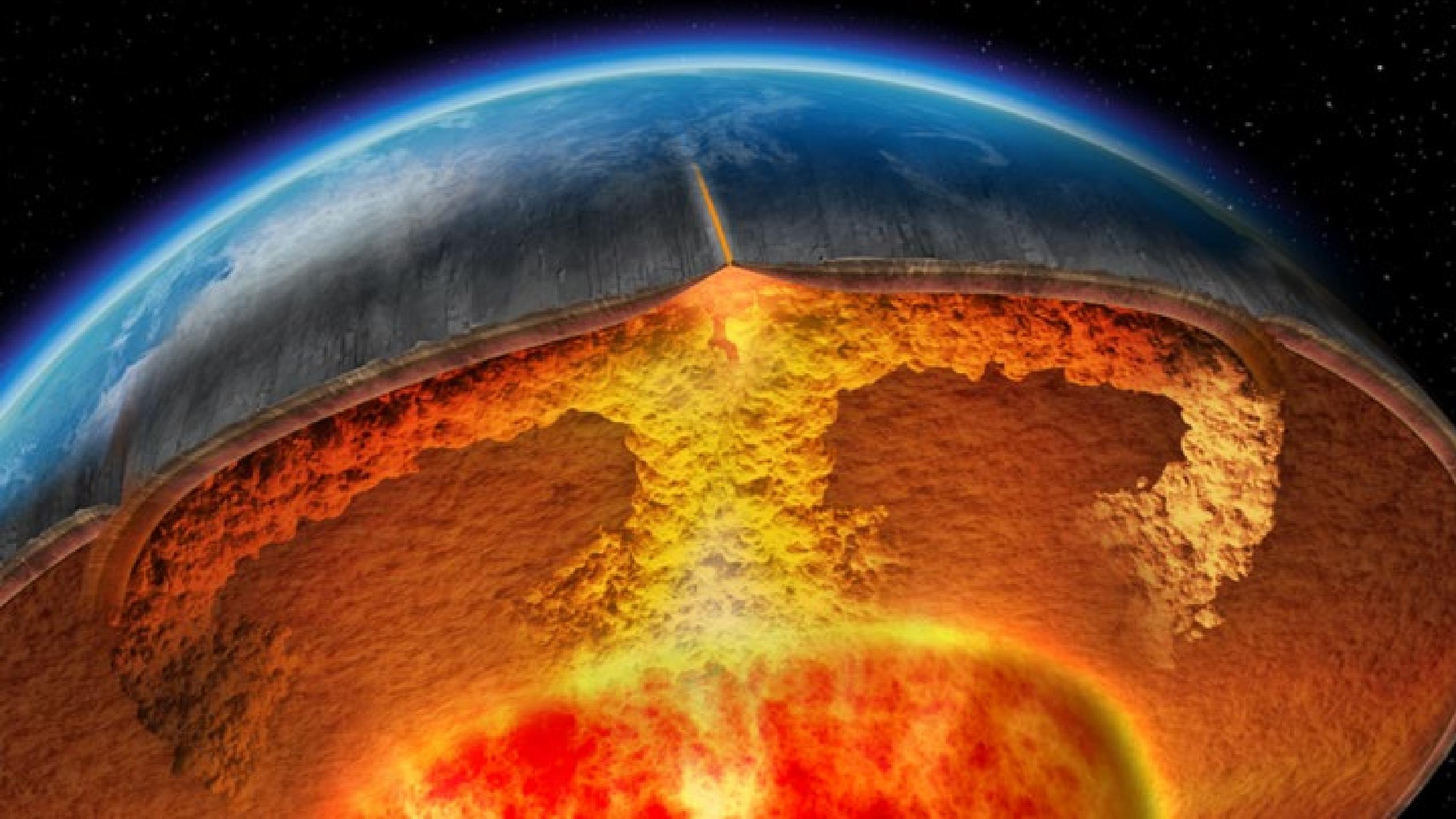
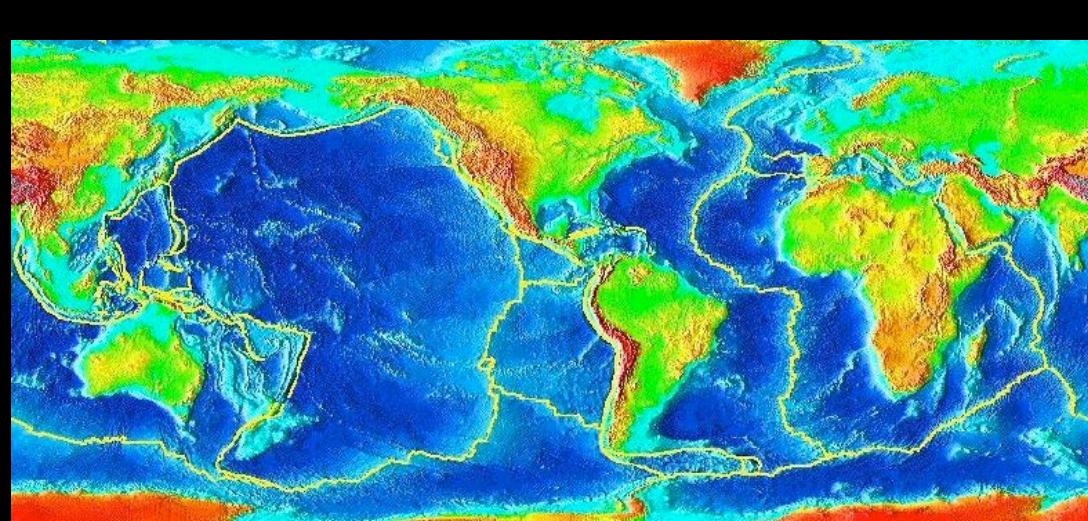
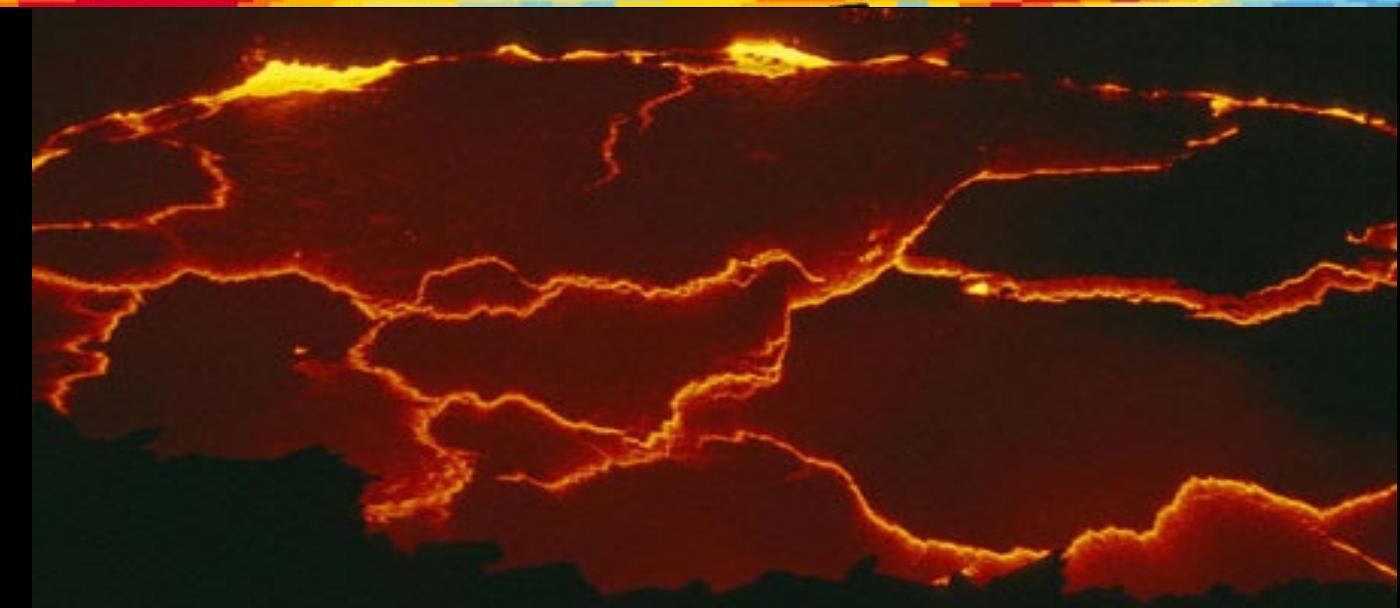
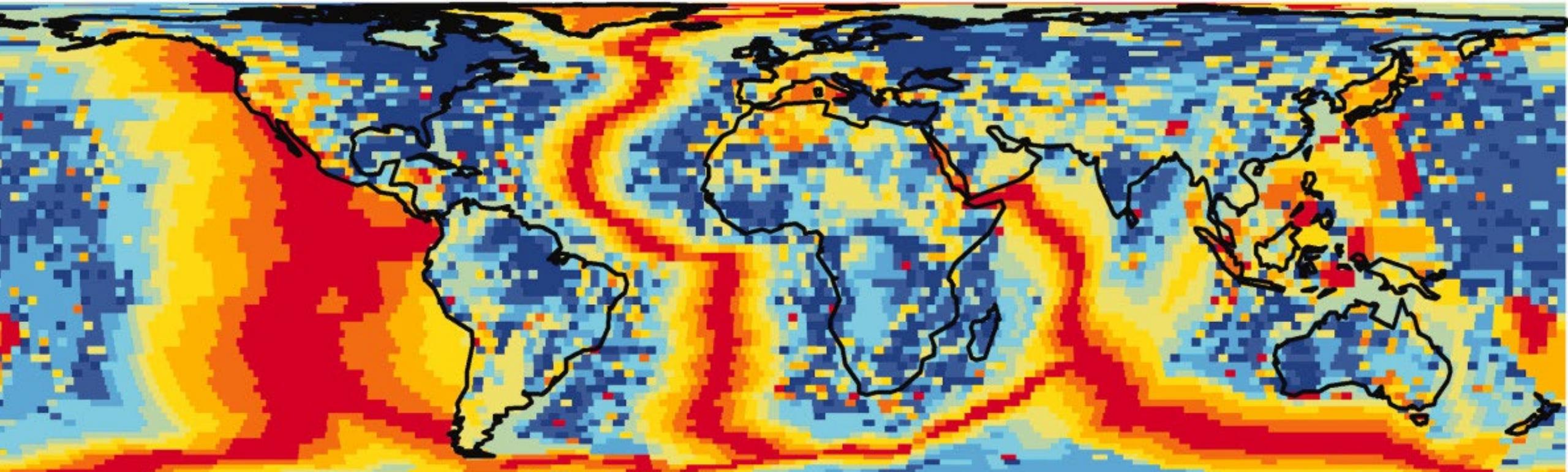
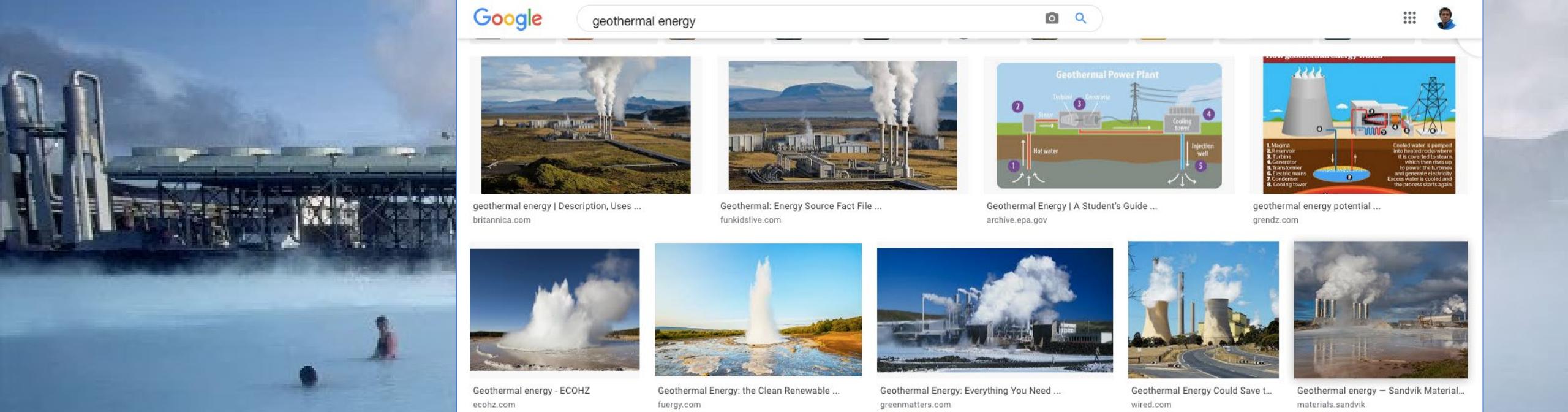


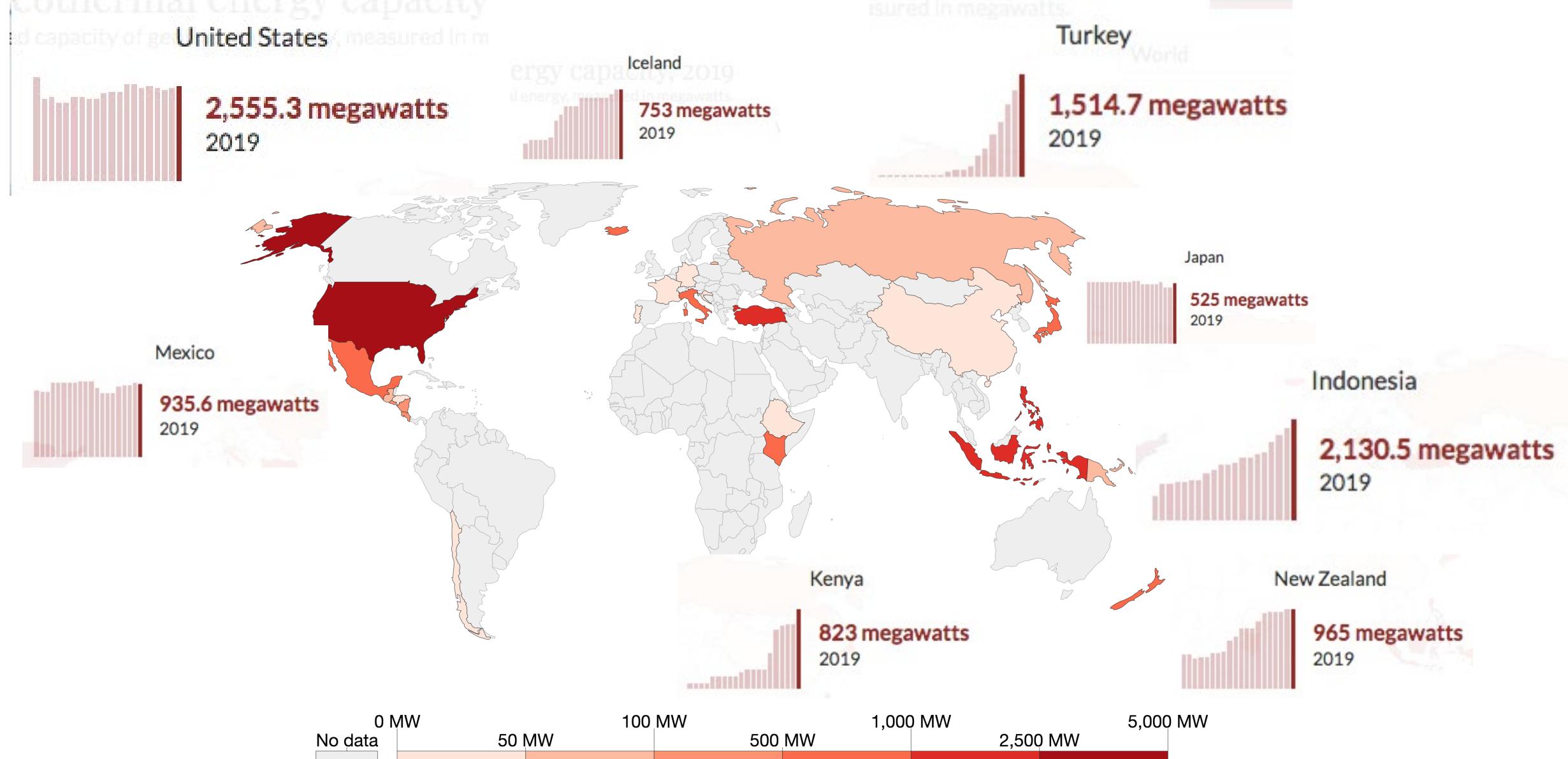


ACT 1 – The Power of the Planet







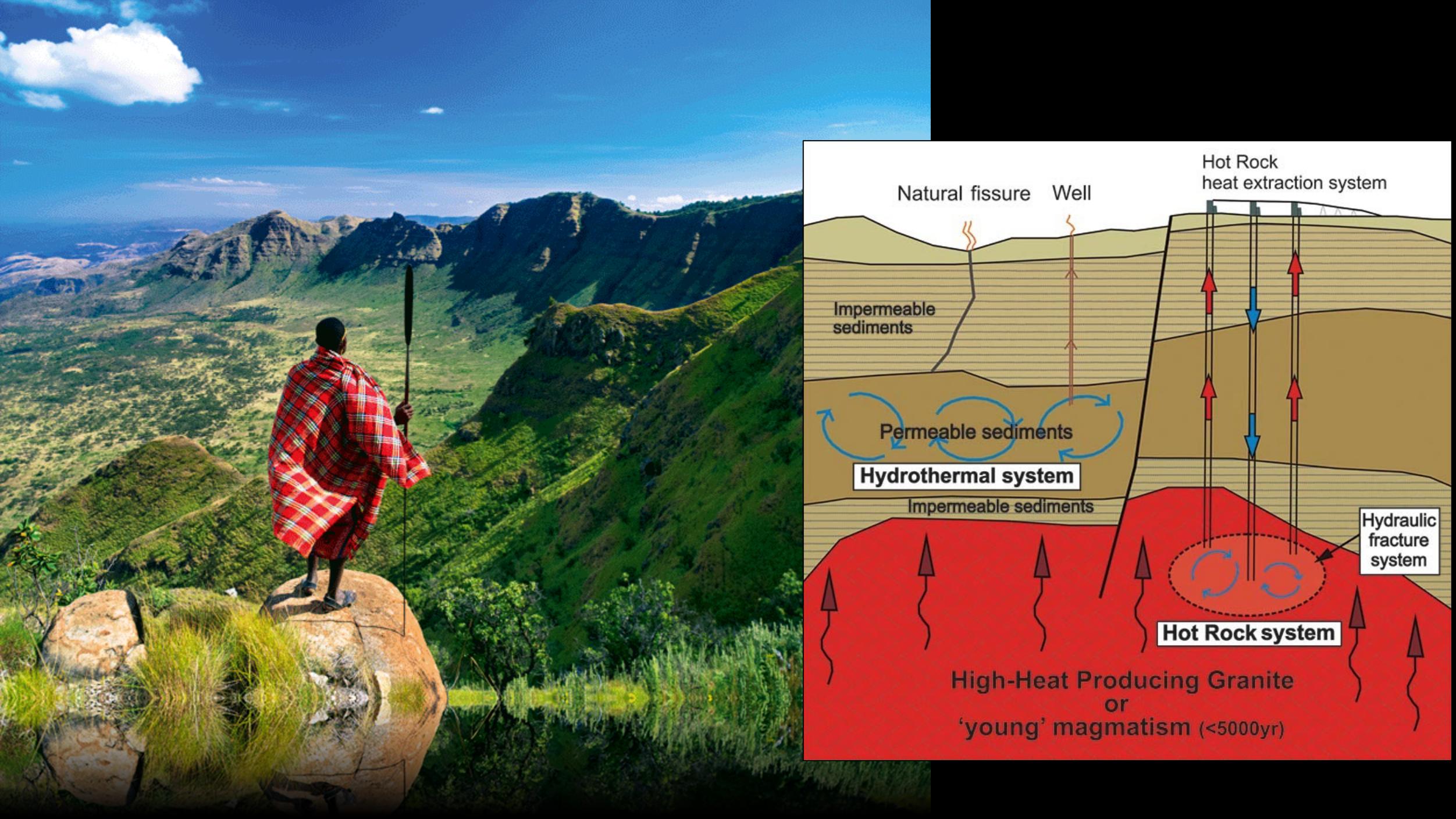


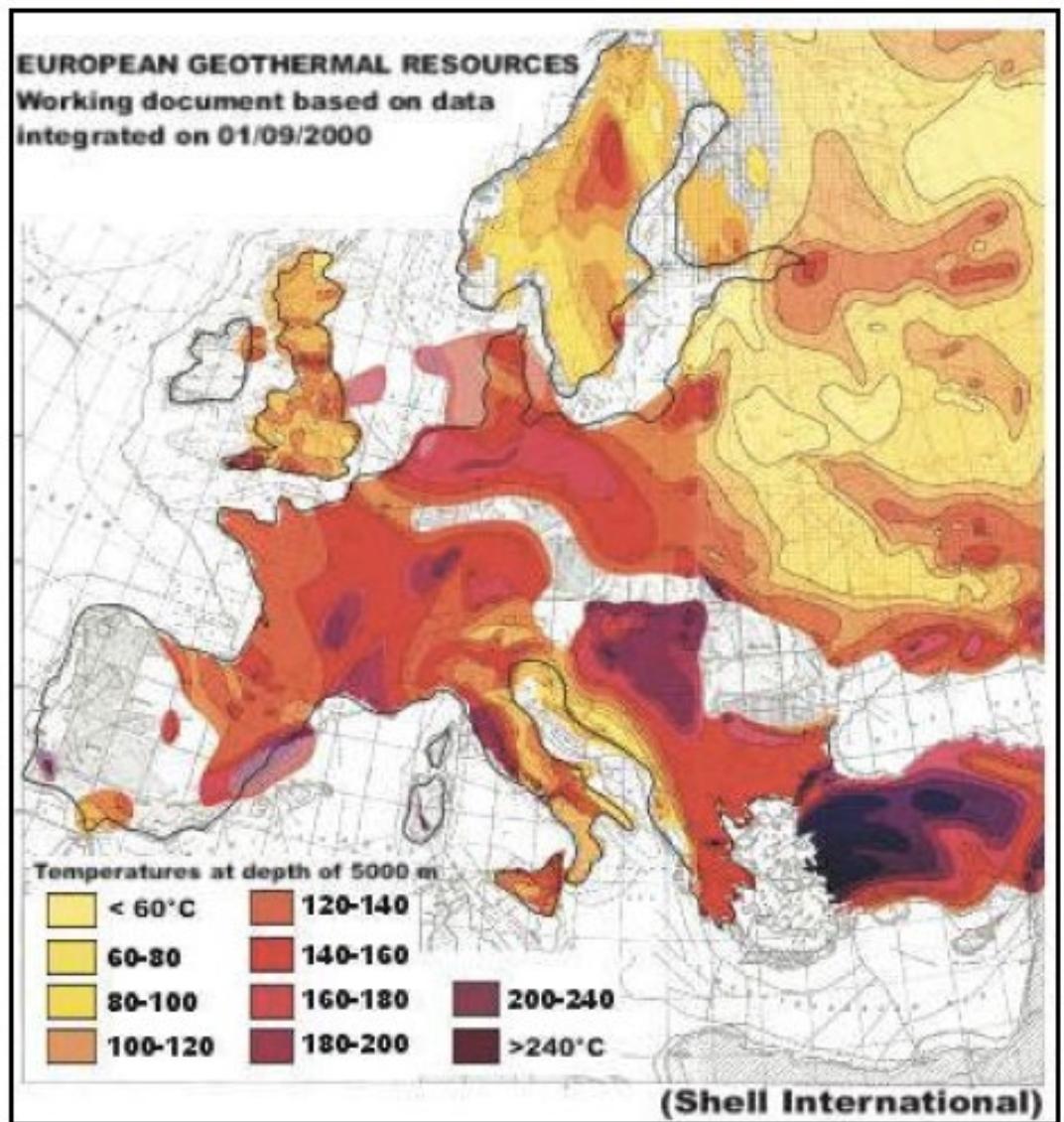
Source: BP Statistical Review of Global Energy (2020)

OurWorldInData.org/renewable-energy • CC BY

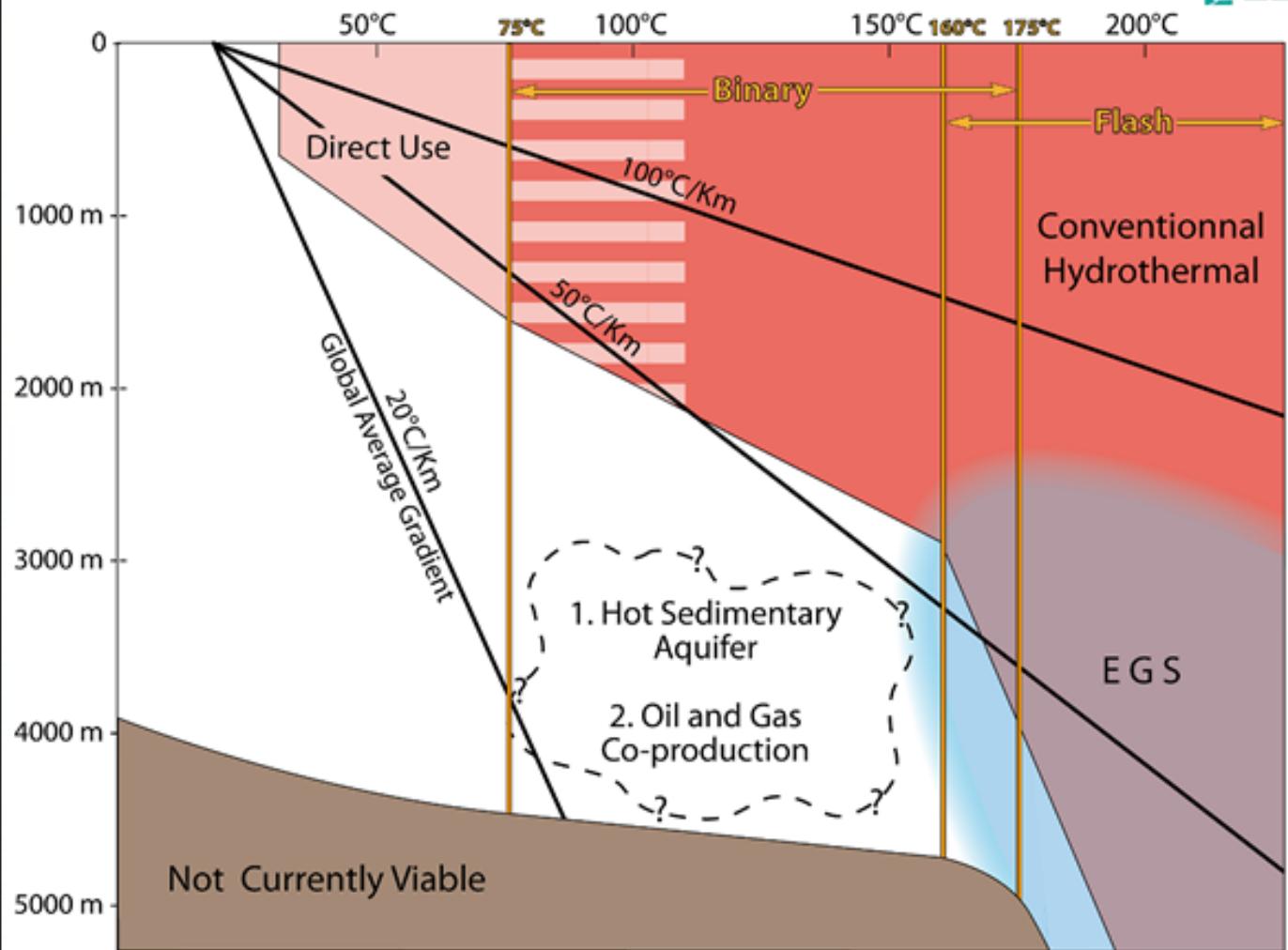
Installed geothermal energy capacity, 2019

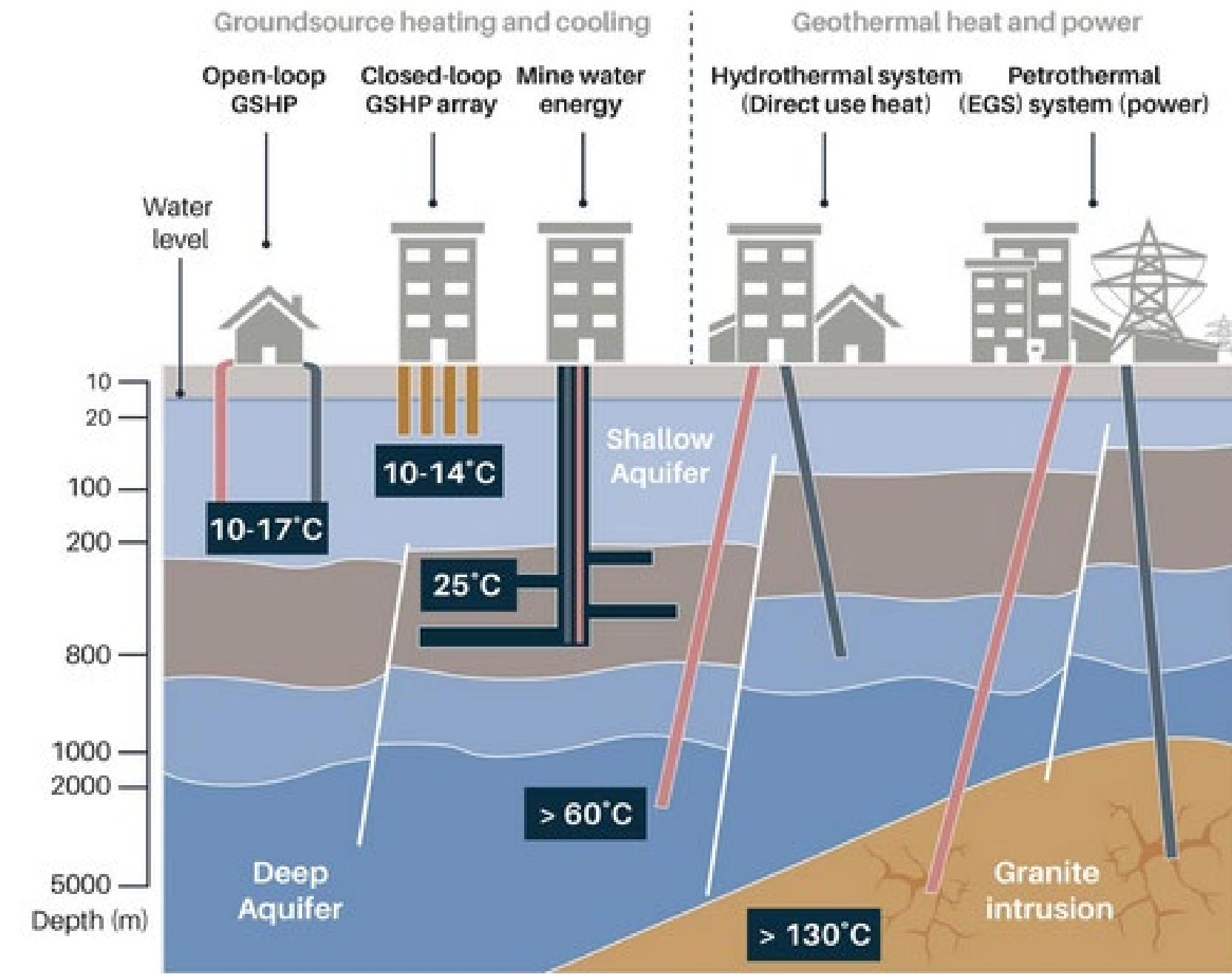
Cumulative installed capacity of geothermal energy, measured in megawatts.





Schematic Depth-Temperature Plot for Geothermal Resources

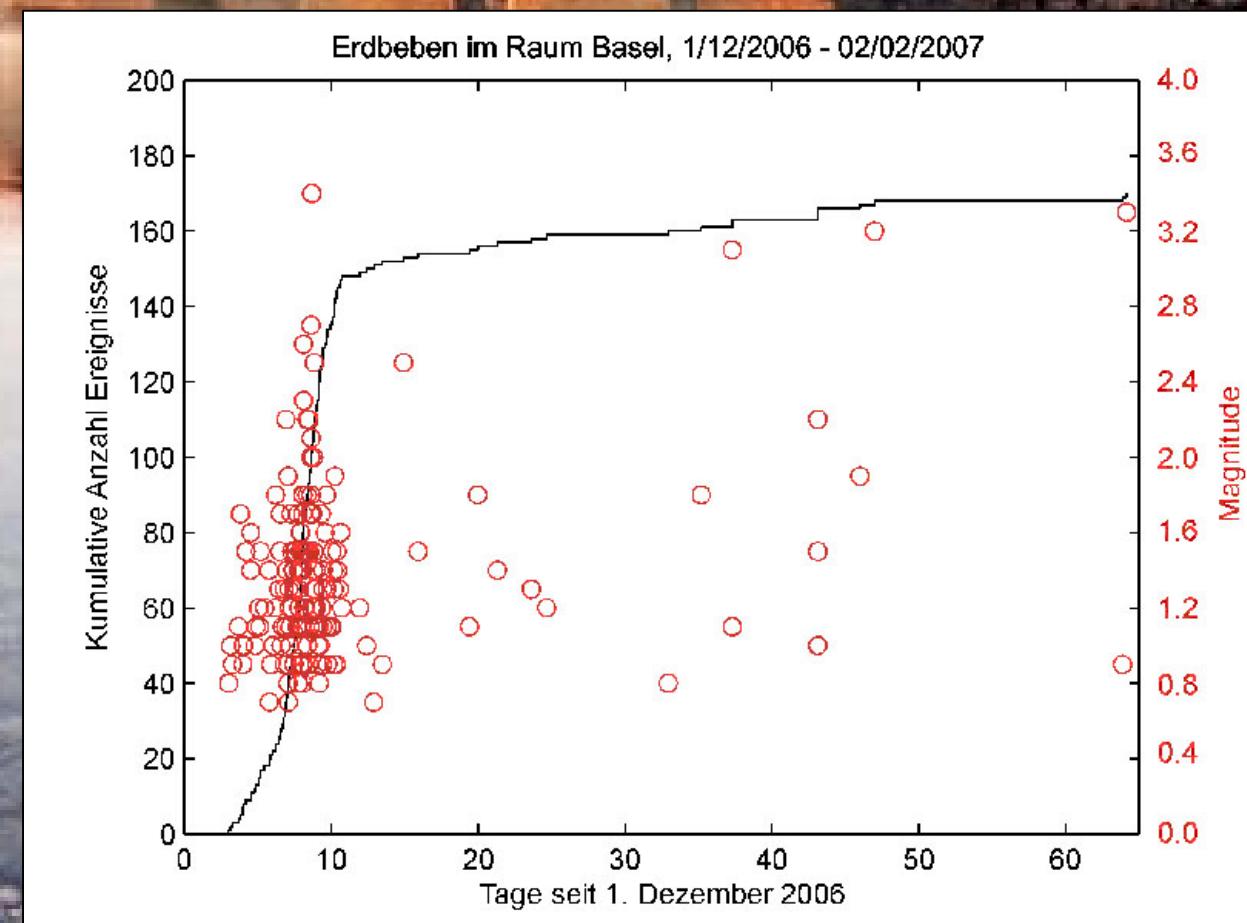




Basel, Switzerland

'Waking up the sleeping terror that lurks in the deep is the plot of numerous movies; here it has an all-too-real meaning'

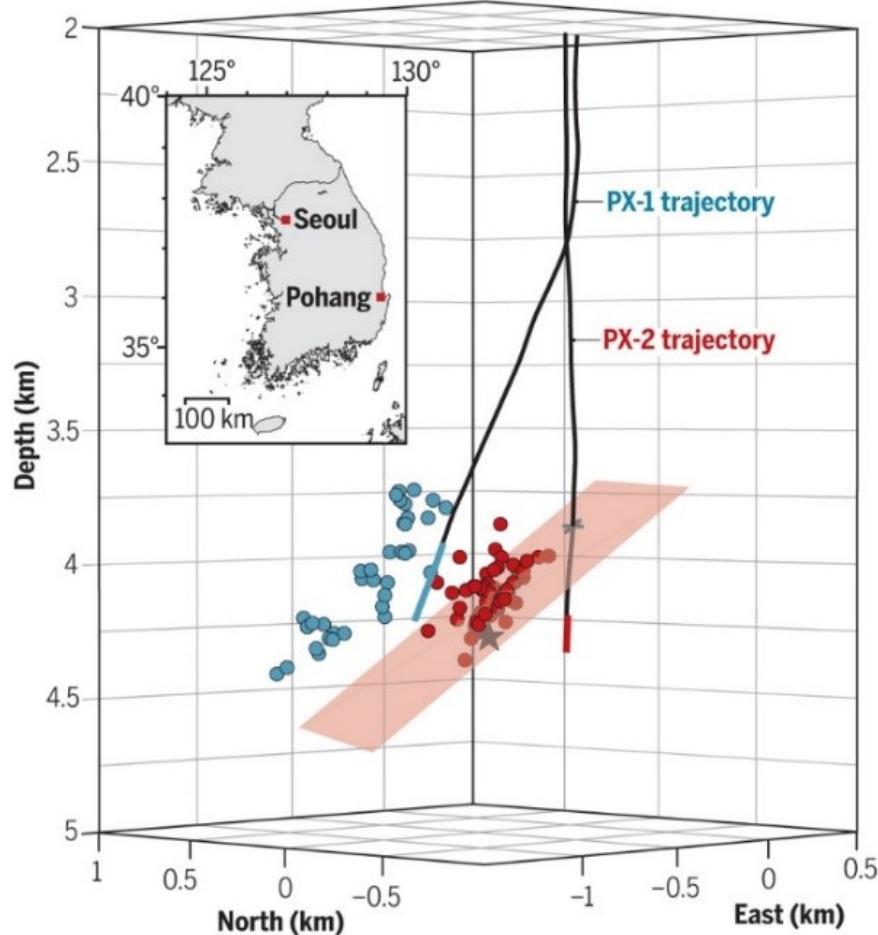
(Giardini, 2009
Geothermal quake risks must be faced. *Nature*)'



Seismicity activated by injections near Pohang

The direction of view is toward the northeast, obliquely along the plane of the previously undetected fault activated by injection into PX-2.

The intersection of this plane with the PX-2 borehole is indicated by "X." The inset shows the location of Pohang, South Korea.



- Events induced by PX-1 stimulation
- Open-hole section of PX-1
- ★ 15 Nov 2017 mainshock hypocenter

- Events induced by PX-2 stimulation
- Open-hole section of PX-2
- Mainshock fault plane



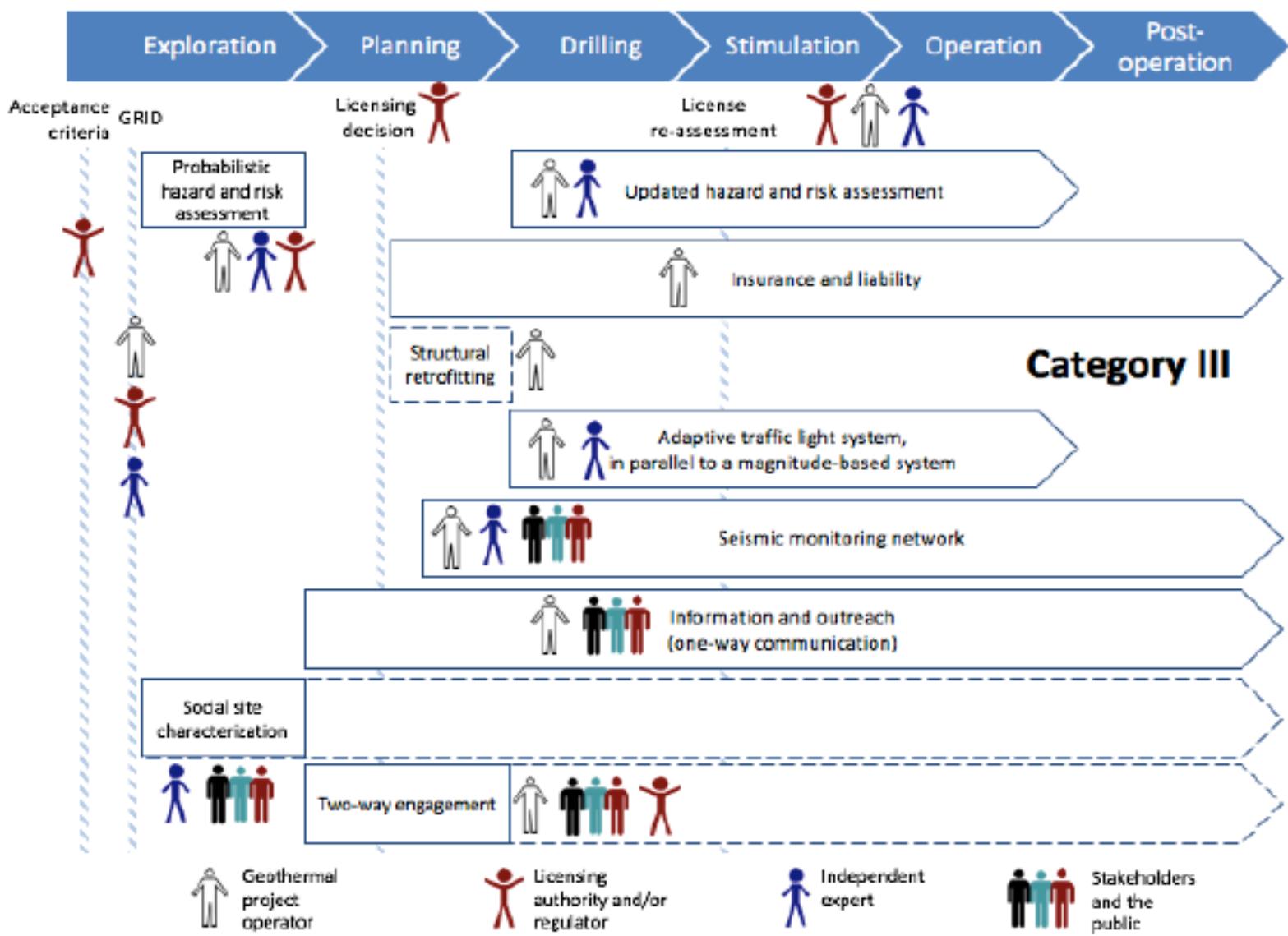


Figure 6. Risk governance measures for GRID Category III projects

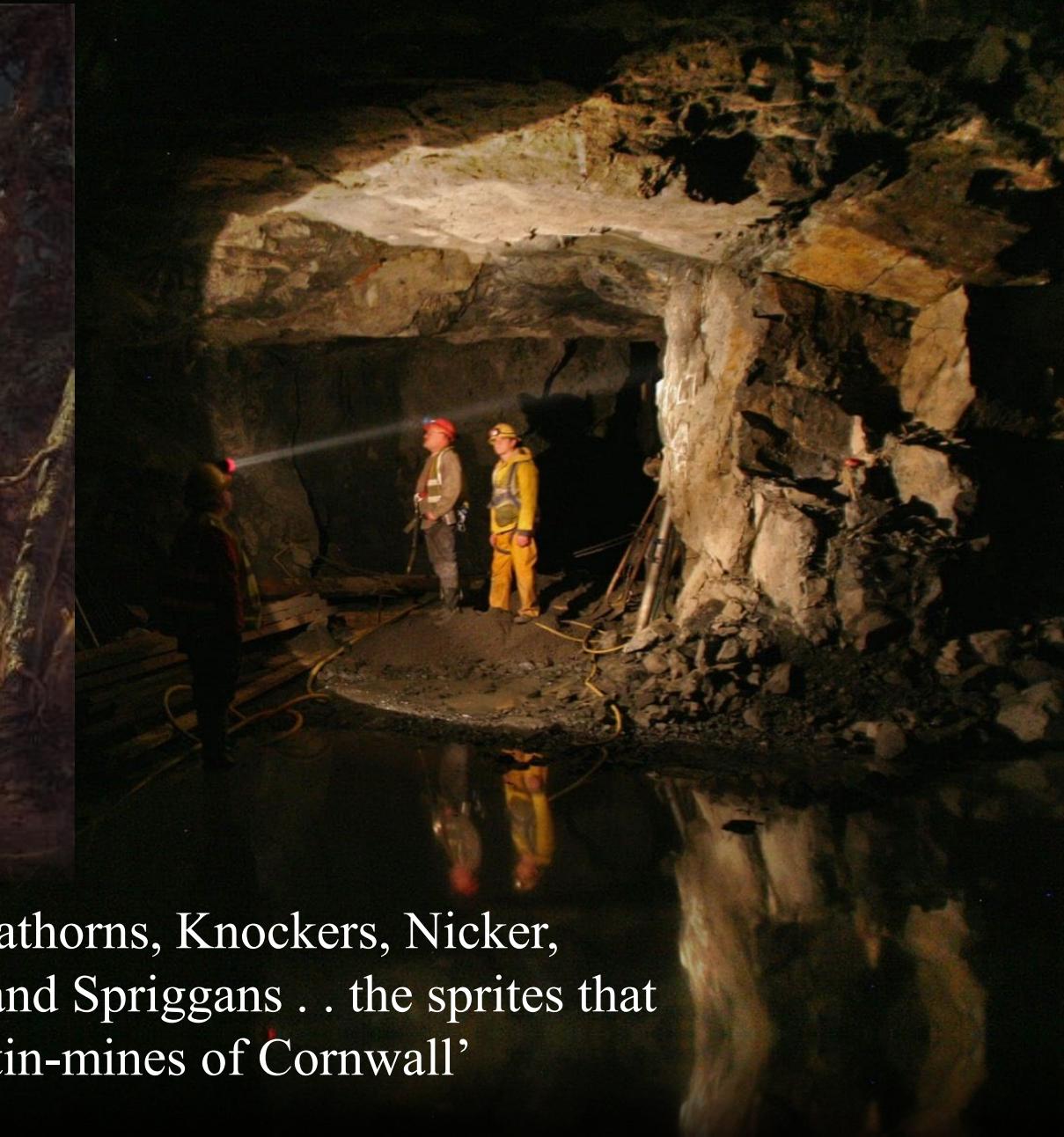
Trutnevyte, E. and Wiemer, S., 2017. Tailor-made risk governance for induced seismicity of geothermal energy projects: An application to Switzerland. *Geothermics*, 65, pp.295-312.



ACT 2

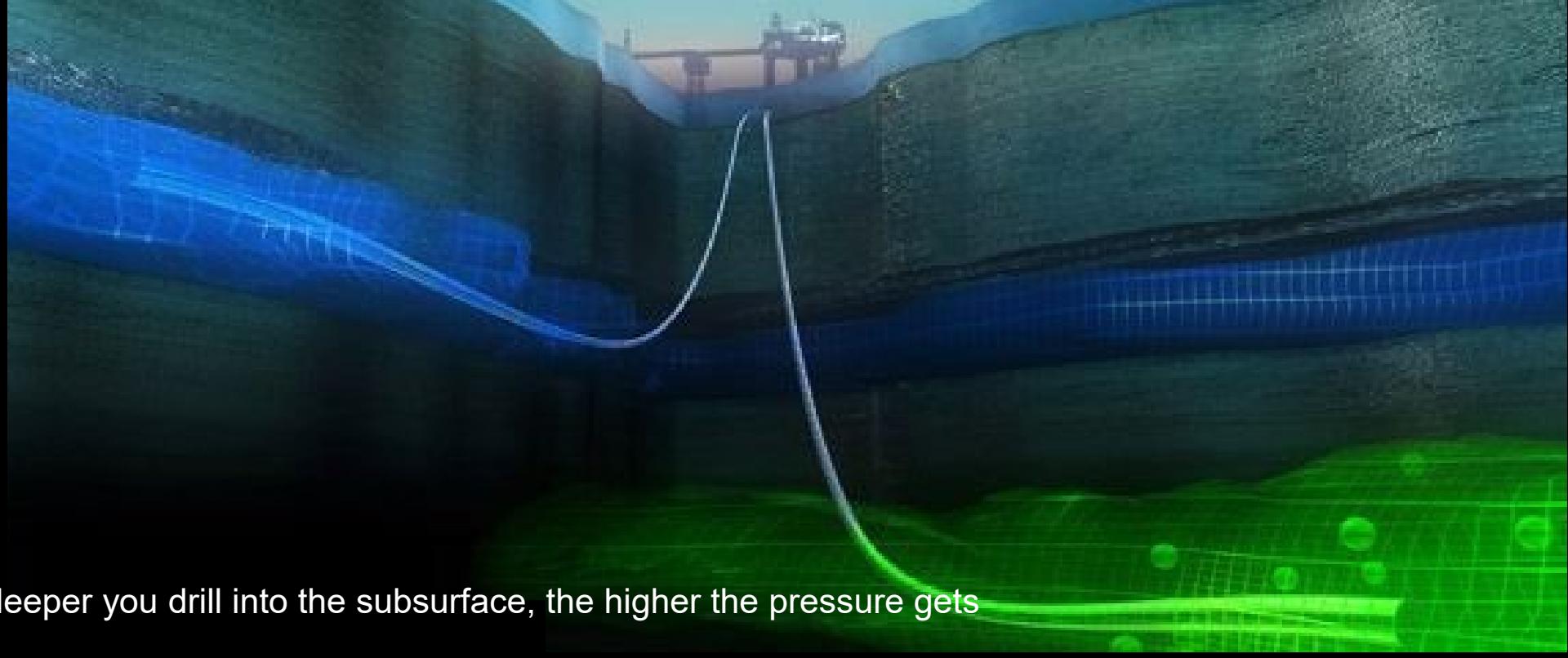
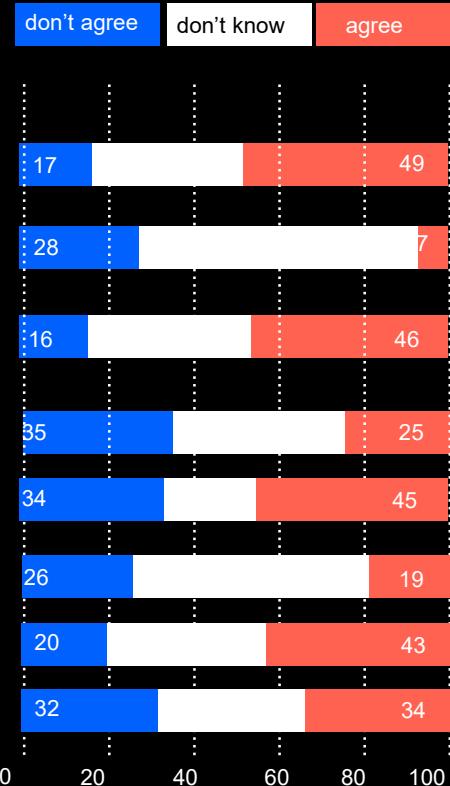
The Land Below Ground

Pythagoras emerging from the Underworld (oil on canvas painting by Salvator Rosa)



‘Bucca, Gathorns, Knockers, Nicker,
Nuggies, and Spriggans . . the sprites that
haunt the tin-mines of Cornwall’

Public Misconceptions



The deeper you drill into the subsurface, the higher the pressure gets

The natural pressure in the depth in which CO₂ is injected is so high that it is kept in a liquid state. Injection of large amounts of CO₂ into the underground leads to permanent pressure change in the subsurface

The injection of CO₂ is comparable to a sponge, which is soaking up the CO₂

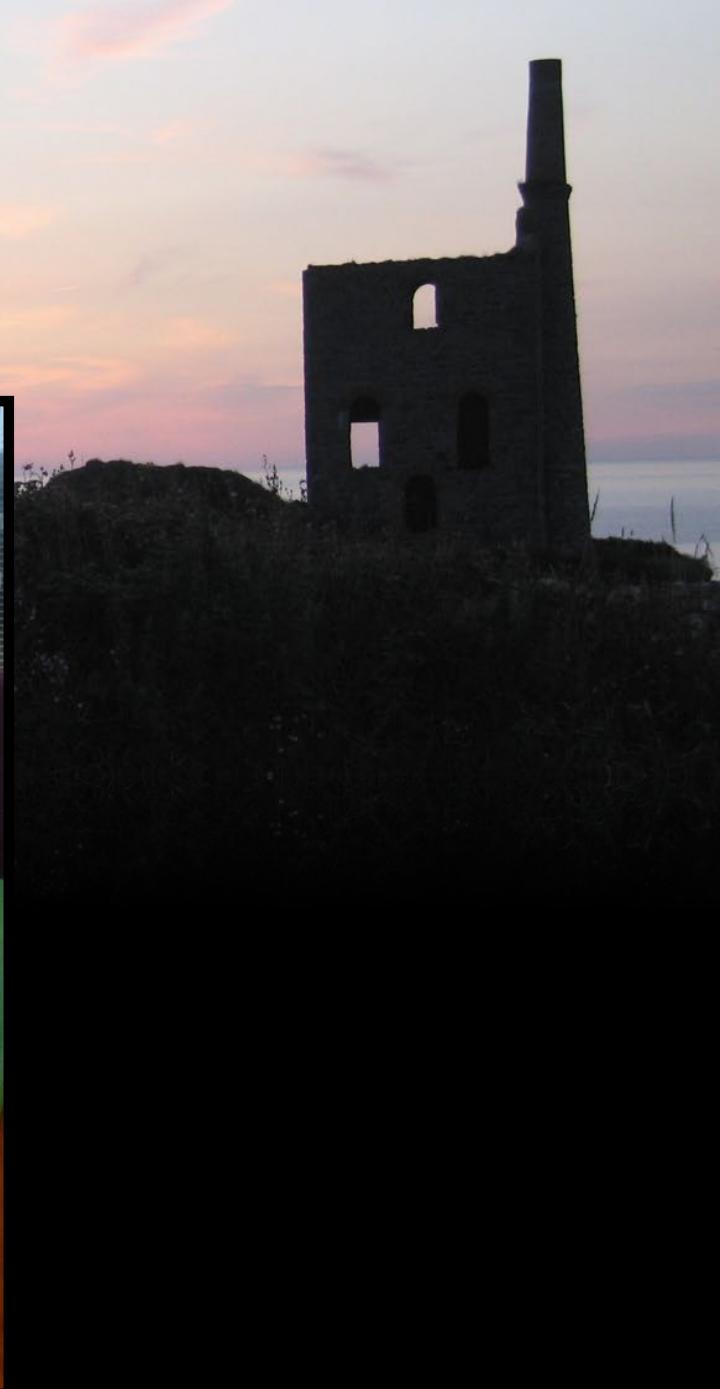
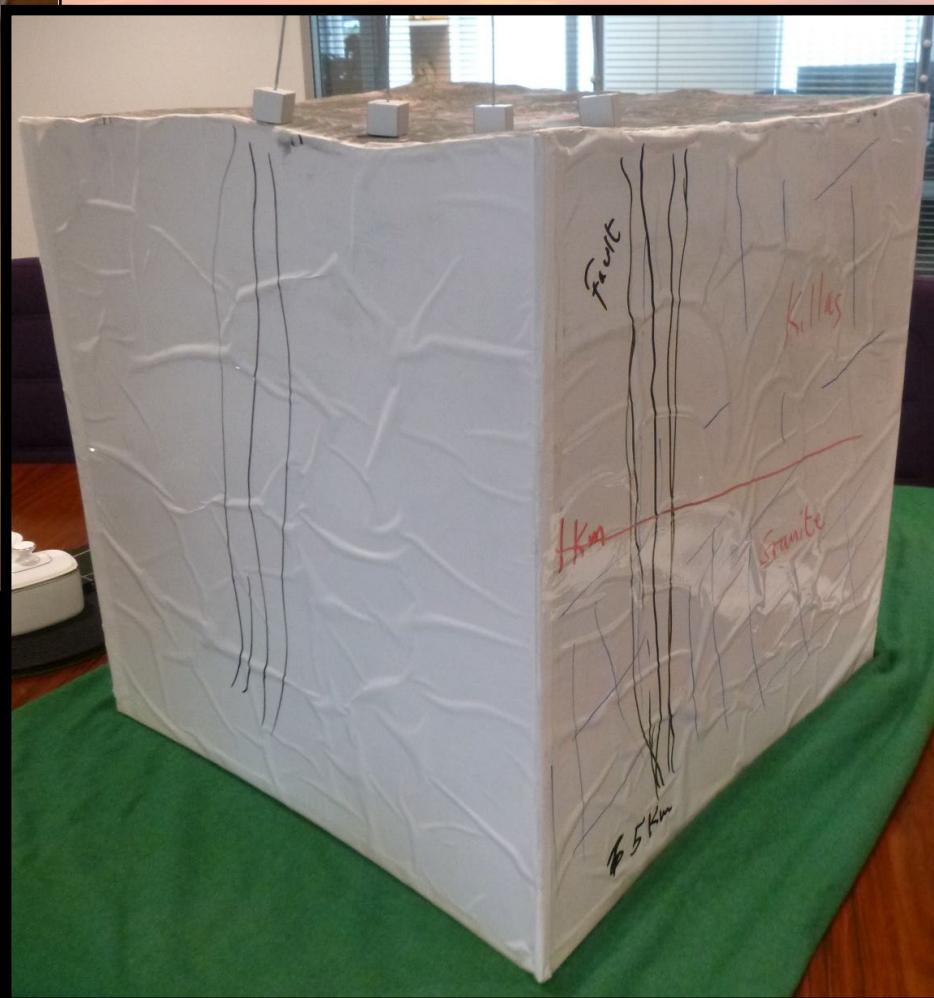
Injecting CO₂ into the subsurface is like pumping up a huge balloon underground

The longer CO₂ stays in the underground, the more it conjoins with the rock and the safer the storage gets

Because CO₂ is a gas, it will rise to the surface sooner or later

CO₂ is heavier than air

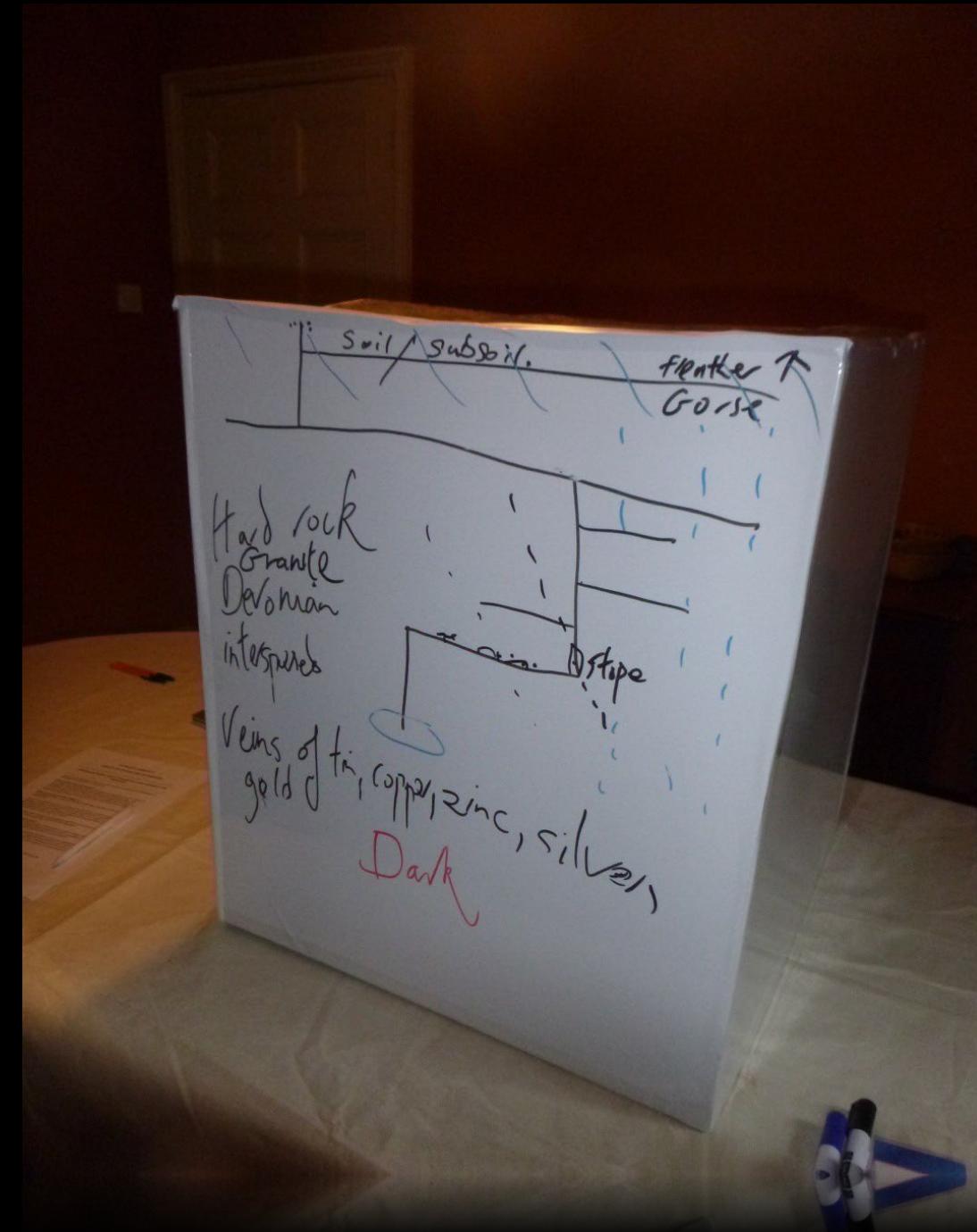
REF: Wallquist, Visschers, & Siegrist 2010. Impact of knowledge and misconceptions on benefit and risk perception of CCS. *Env. Sci. Technol.*, 2, 81-101.



“And you keep going down
and down until you
eventually hit, I take it, very
hot rocks and the coal there.

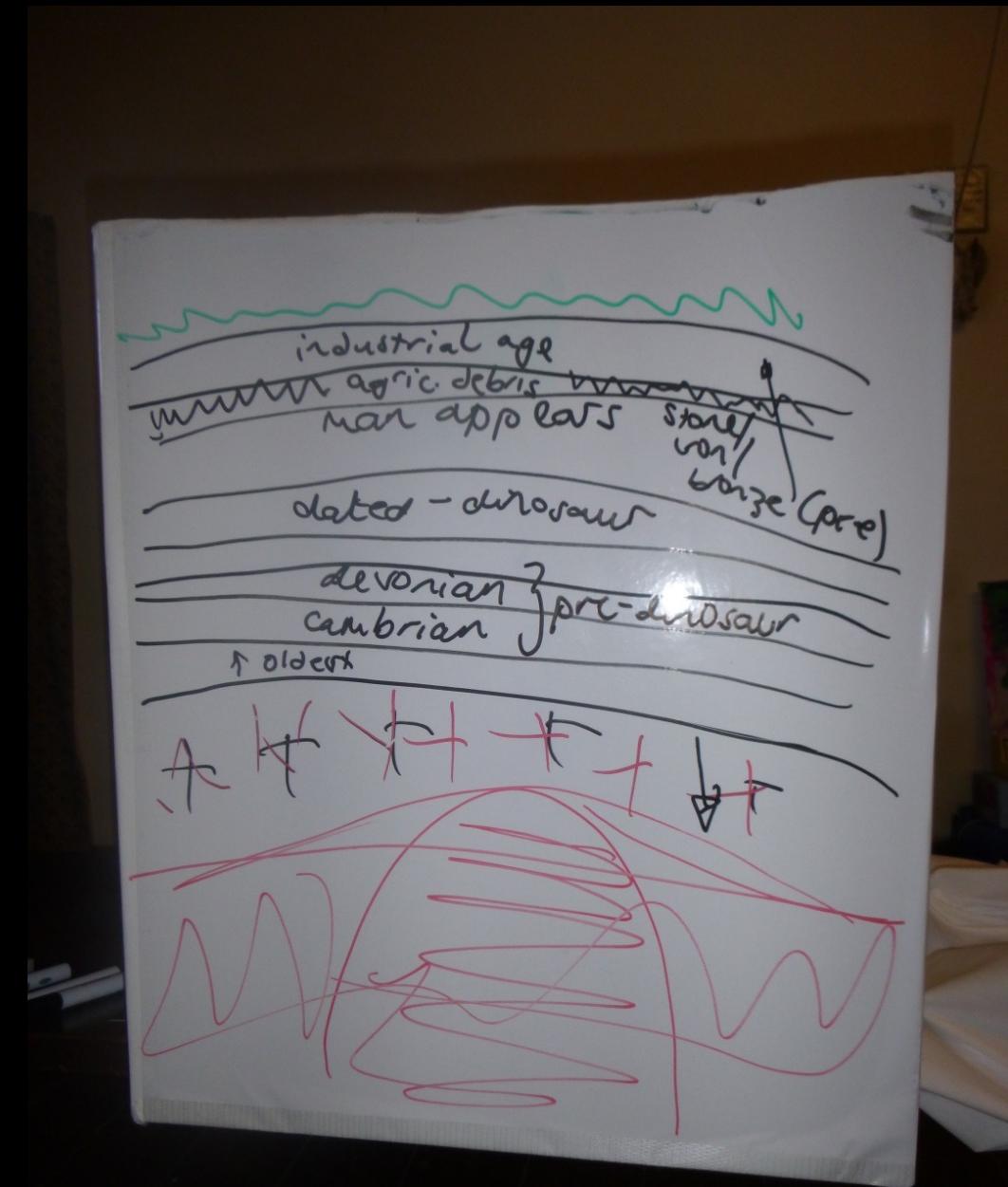
If it's not from the heat being
radiated, it's from being
enclosed, I'm sure it will get
hotter.

Decent miners, a lot of
miners there, they're virtually
in the nude because it's so
hot.”



“So down towards the very, very bottom of the Earth.

That's because it's where it's all broken down even more and I presume that's where the heat of the Earth is.”





Hydro. Earth Syst. Sci., 20, 1737–1749, 2016
www.hydrol-earth-syst-sci.net/2017/2016/
doi:10.5194/hess-20-1737-2016
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Hydrology and
Earth System
Sciences

A “mental models” approach to the communication of subsurface hydrology and hazards

Hazel Gibson¹, Iain S. Stewart¹, Sabine Pahl², and Alison Stokes¹

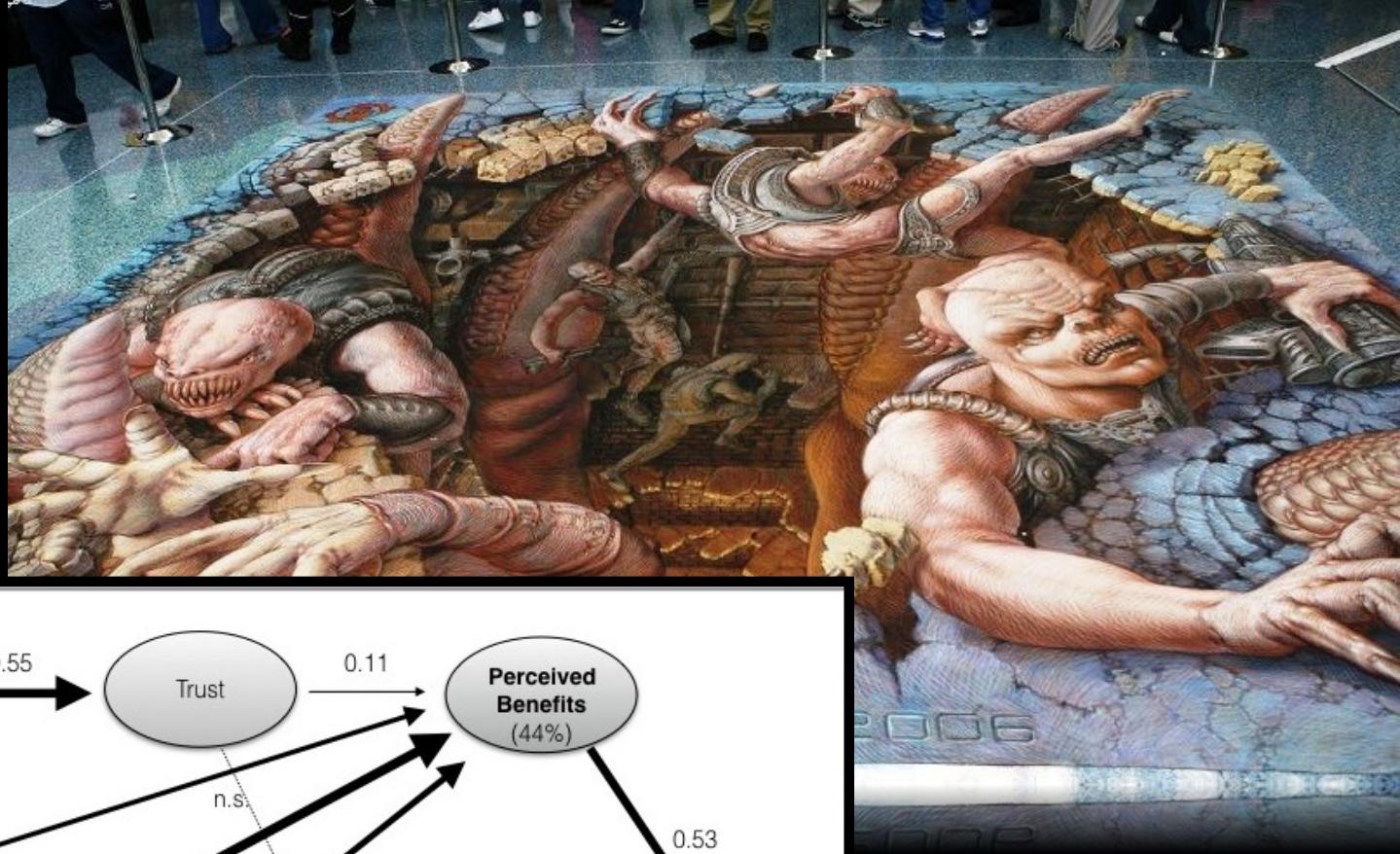
¹School of Geography, Earth and Environmental Sciences, Plymouth University, Plymouth, UK

²School of Psychology, Plymouth University, Plymouth, UK

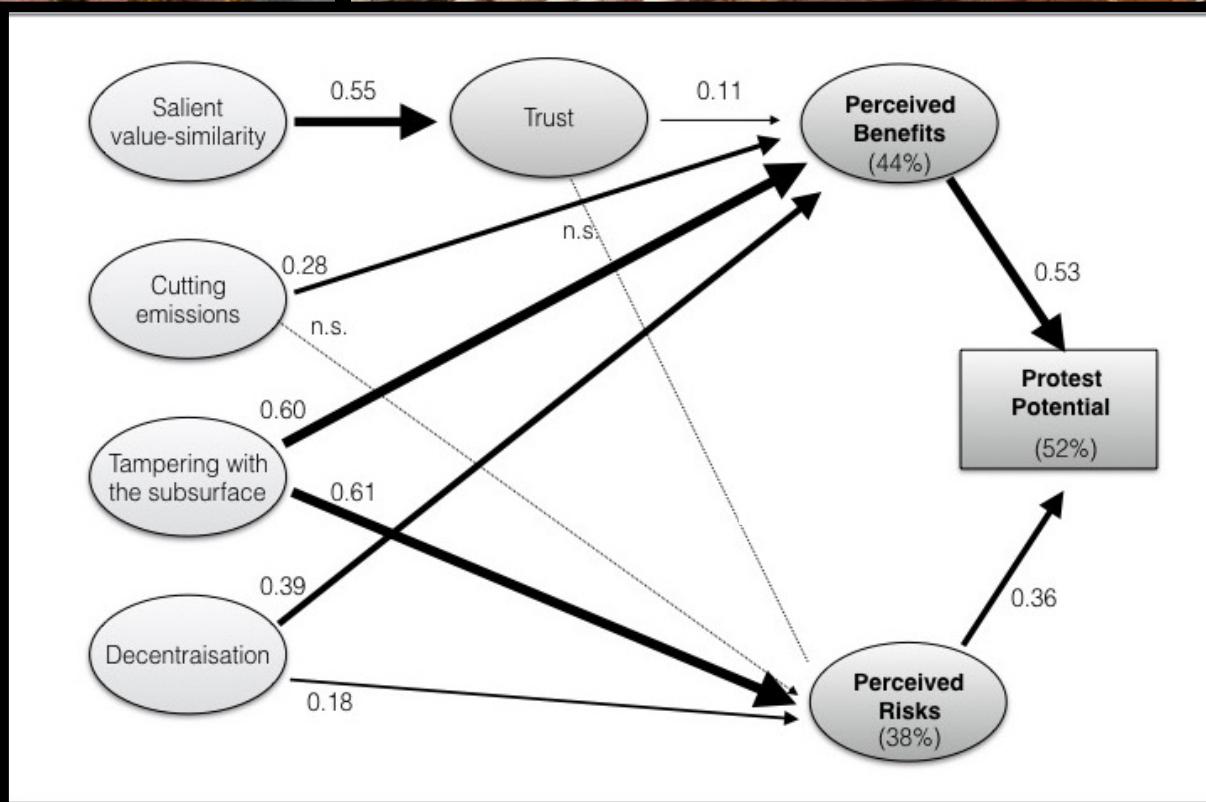
Correspondence to: Hazel Gibson (hazel.gibson@plymouth.ac.uk)

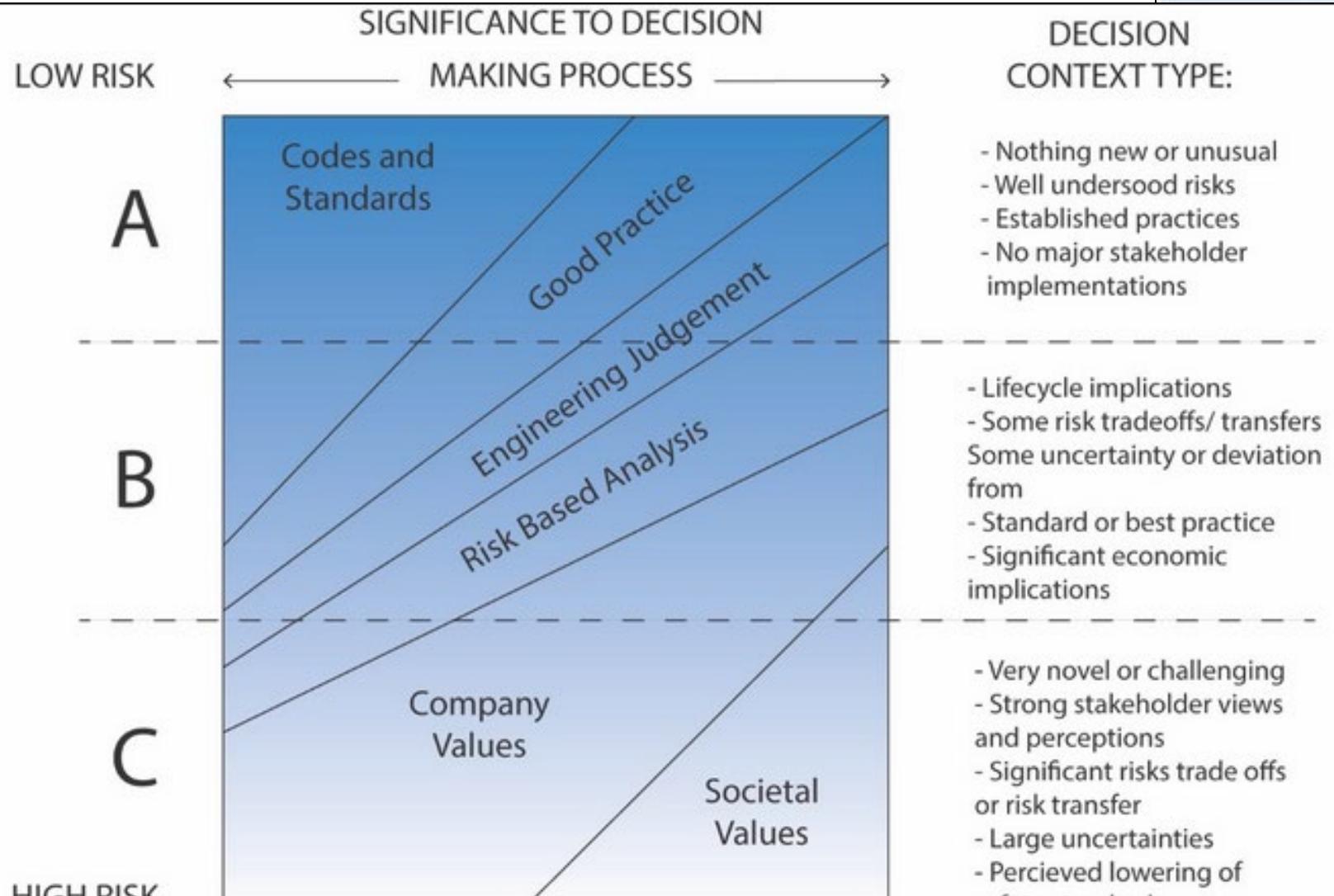
Received: 16 December 2015 – Published in *Hydro. Earth Syst. Sci. Discuss.*: 18 January 2016

Revised: 12 April 2016 – Accepted: 15 April 2016 – Published: 4 May 2016



Tampering with the subsurface

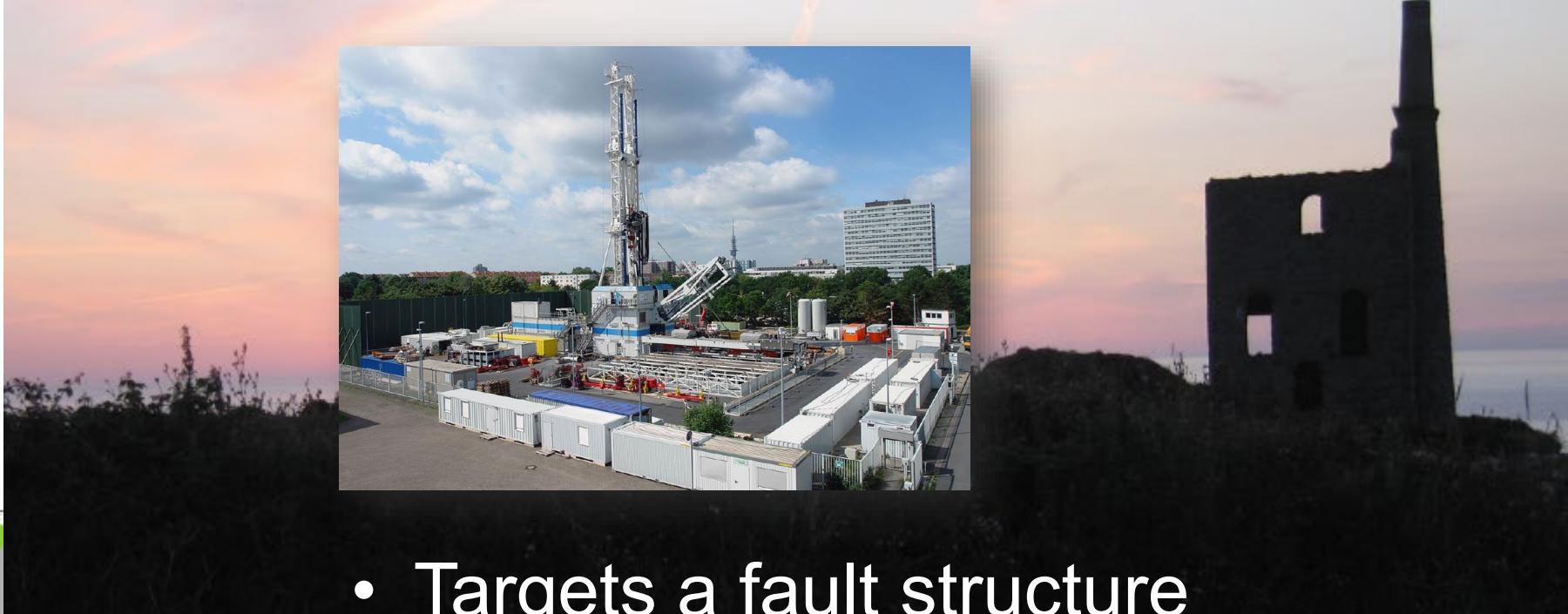
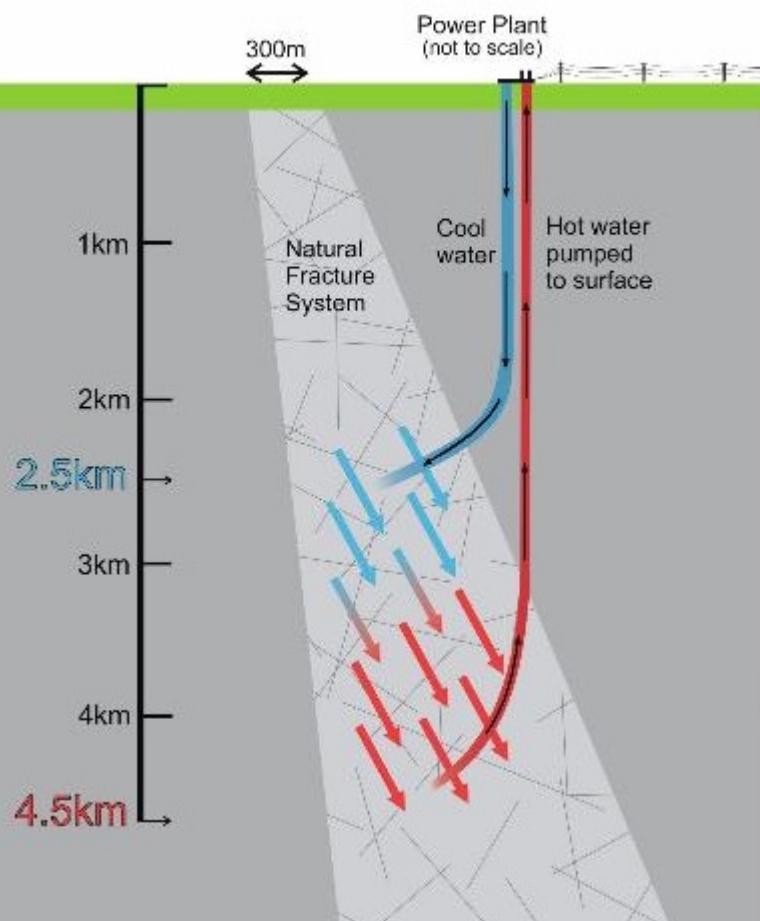






Act 3 - Taking the heat out
of geothermal





- Targets a fault structure
- 20 to 80 l/s circulation
- 175°C at surface
- Pilot power plant
- 1 – 3 We to the grid
- Local use of heat?



Peter Ledingham
Lucy Cotton



United Downs Deep Geothermal Power Project



The UDDGP project is the first geothermal power plant in the UK. It is funded by a mixture of public and private funds to include the European Regional Development Fund, Cornwall Council and Thrive Renewables plc. The aim of the project is to produce power and heat from the hot granite rocks beneath Cornwall at the United Downs Industrial Site near Redruth. Two deep, directional wells have successfully been drilled; the production well to a depth of 5275m and the injection well to 2393m. Both wells have intersected the target Porthtowan Fault Zone located approximately 800m to the west of the site.

Our latest Tweets

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[United Downs Deep Geothermal Power Project \(UDDGP\)](#)
5 days ago

Our testing schedule started on Tuesday and will finish at lunchtime today. Yesterday we didn't perform any tests, however today we are going to run some very low level tests in the morning that are highly unlikely to cause any felt seismicity. If you do have concerns contact us. <https://t.co/Gt7vxjmjbx>

[Read More >>](#)



[United Downs Deep Geothermal Power Project \(UDDGP\)](#)
6 days ago

Yesterday @GELtd responded immediately to the micro-seismic events by reducing the water flow. When the flow stops, the pressure readjusts, which takes time and it's not unusual for residual micro-seismic events to occur after stopping. <https://t.co/bI2TTiYrR>

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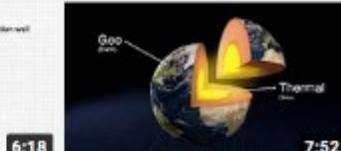
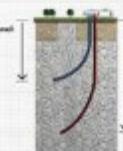
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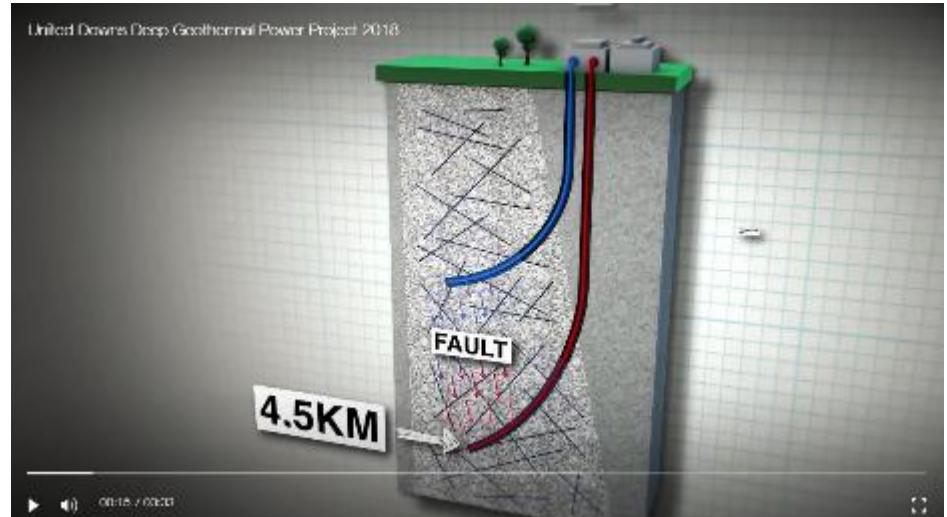
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United Downs Deep Geothermal Power Project 2018



Underground (seismicity)



GEL and seismicity



Earthquakes in Cornwall



Natural or Induced



Magnitude



Seismometers

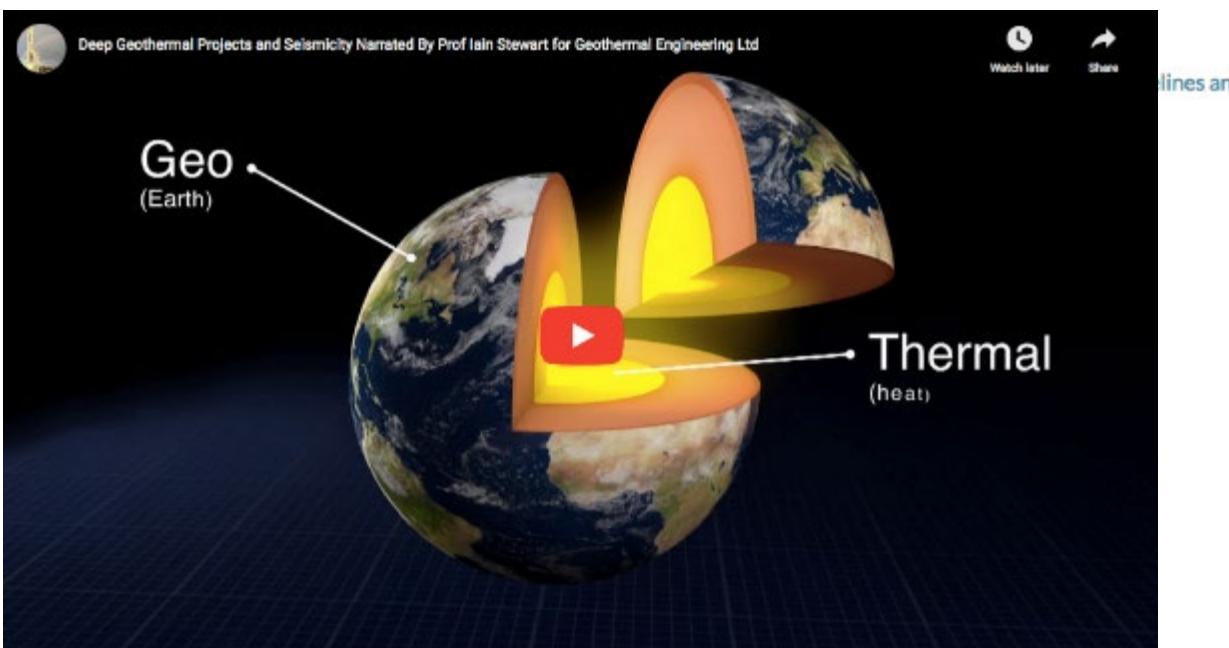


Management and control

GEL and seismicity

“

It's not the unknown we fear, but what we think we know about the unknown.



Tweets

ITED WNS United Downs Deep Geothermal Power Project (UDDGP) @... · 30m ⓘ
Our testing schedule started on Tuesday and will finish at lunchtime today. Yesterday we didn't perform any tests, however today we are going to run some very low level tests in the morning that are highly unlikely to cause any felt seismicity. If you do have concerns contact us.

Tweets & replies

Media

Likes



Deep Geothermal Projects and Seismicity Narrated By Prof Iain Stewart for Geothermal Engineering Ltd

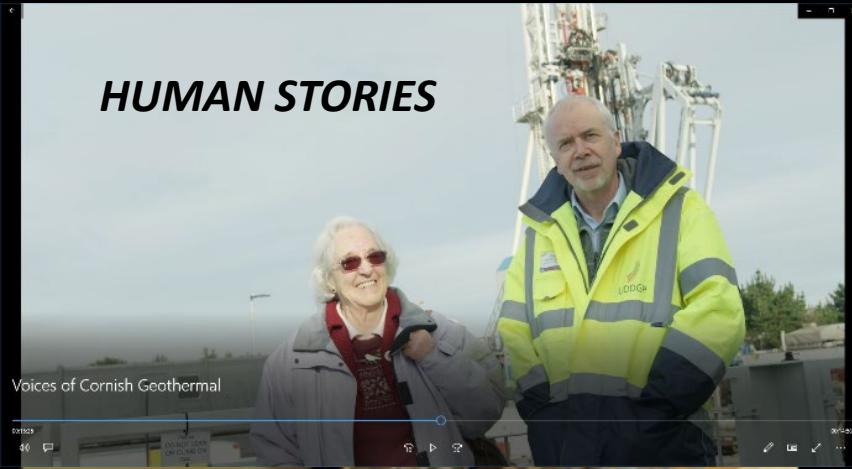
Watch on it on YouTube
[YouTube](#)

Read about Geothermal management and control of seismicity on the UDDGP project web page in the Underground section



UDDGP Website
<https://geothermalengineeri>

HUMAN STORIES



*The
Community
Advocate*

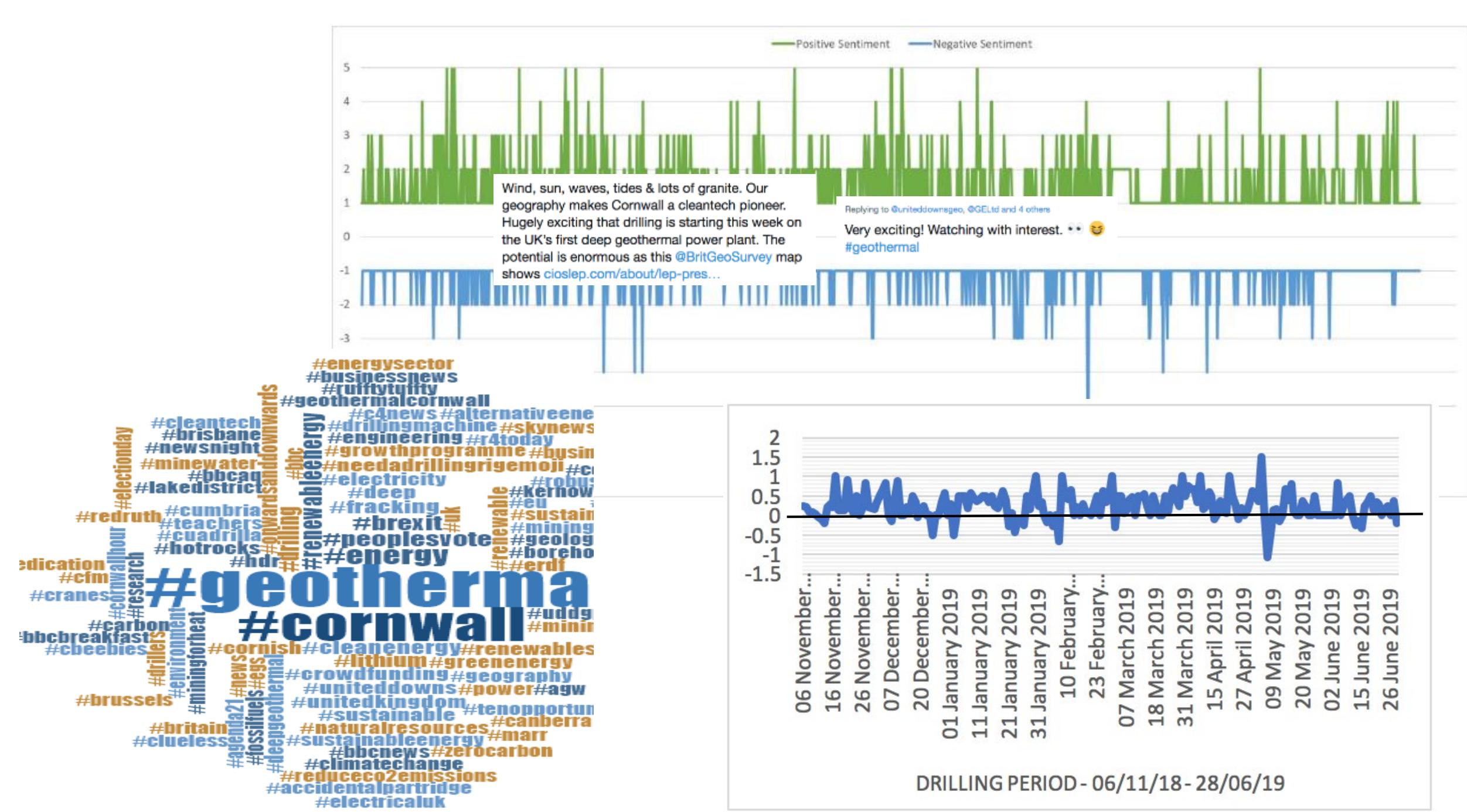


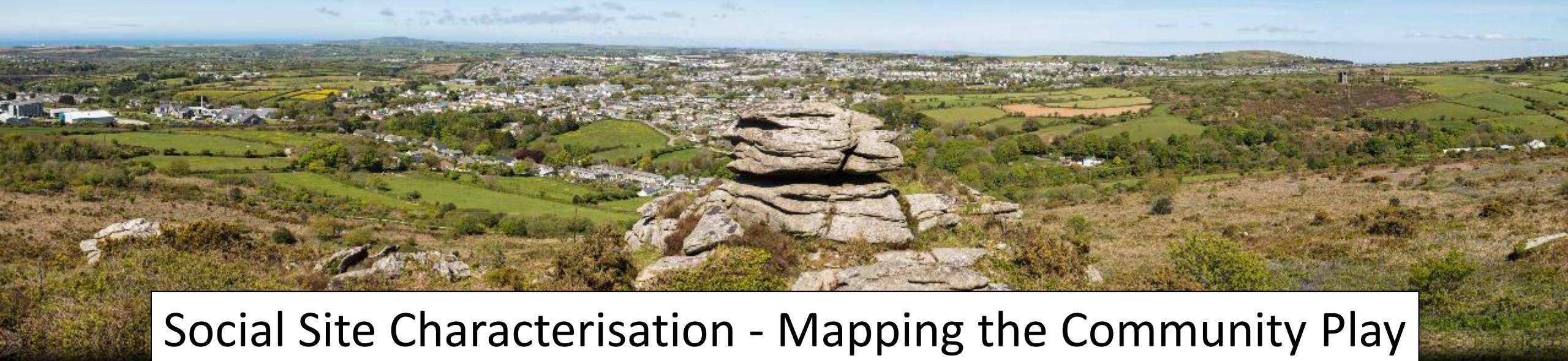
The Operator



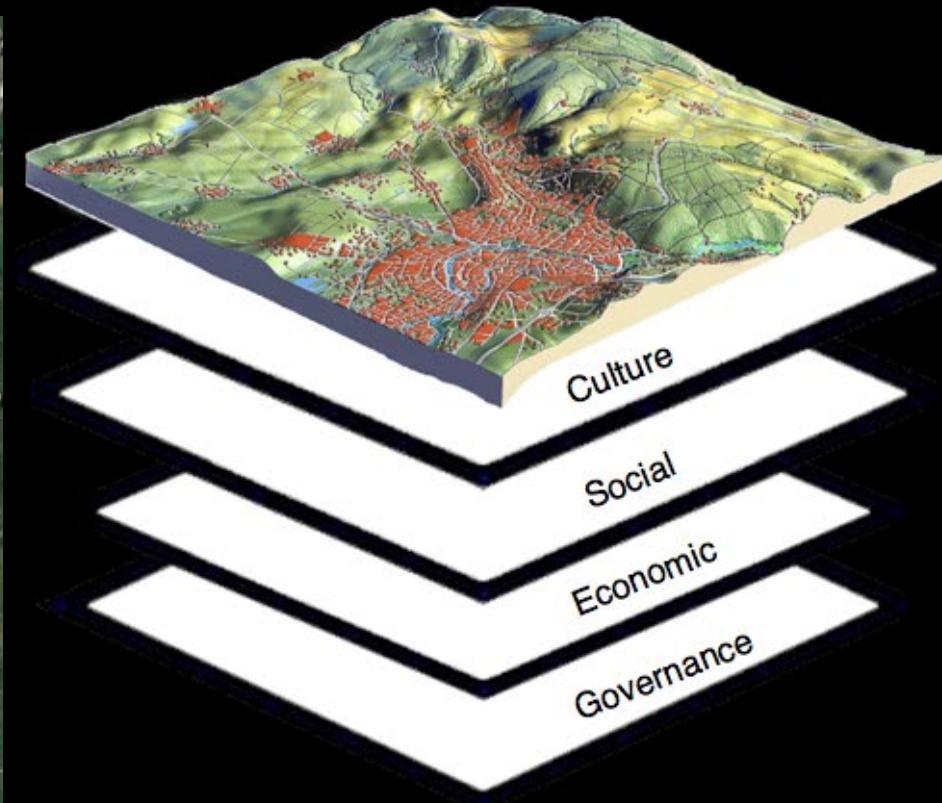
voices of Cornish geothermal



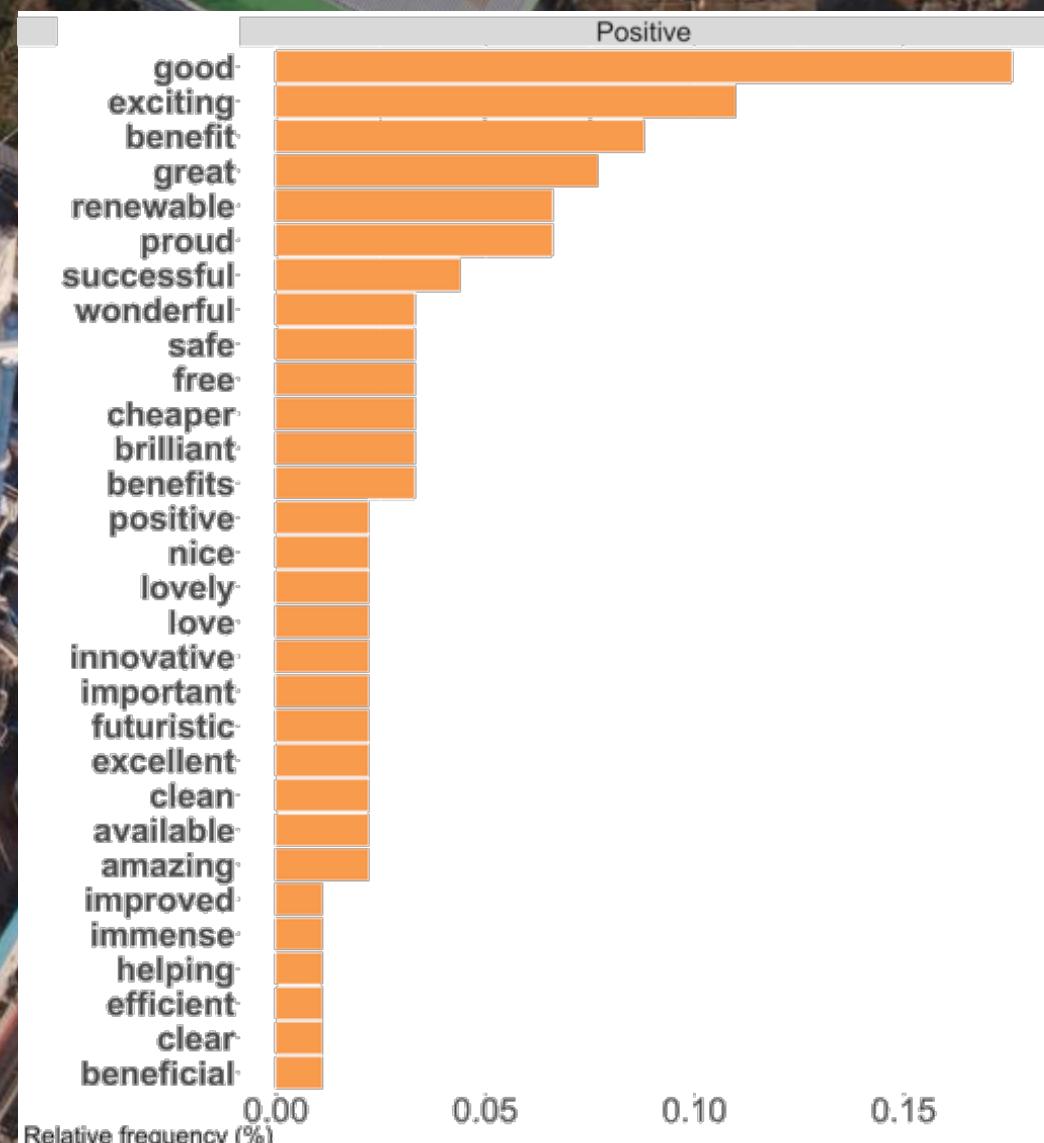
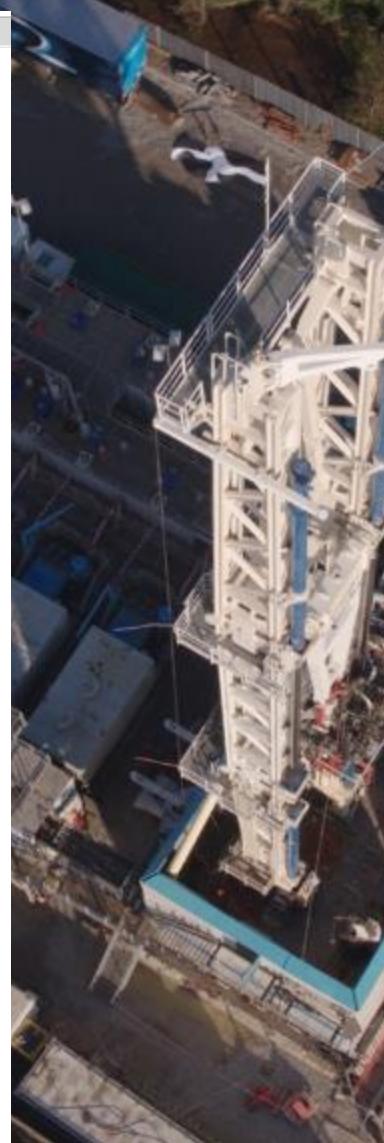
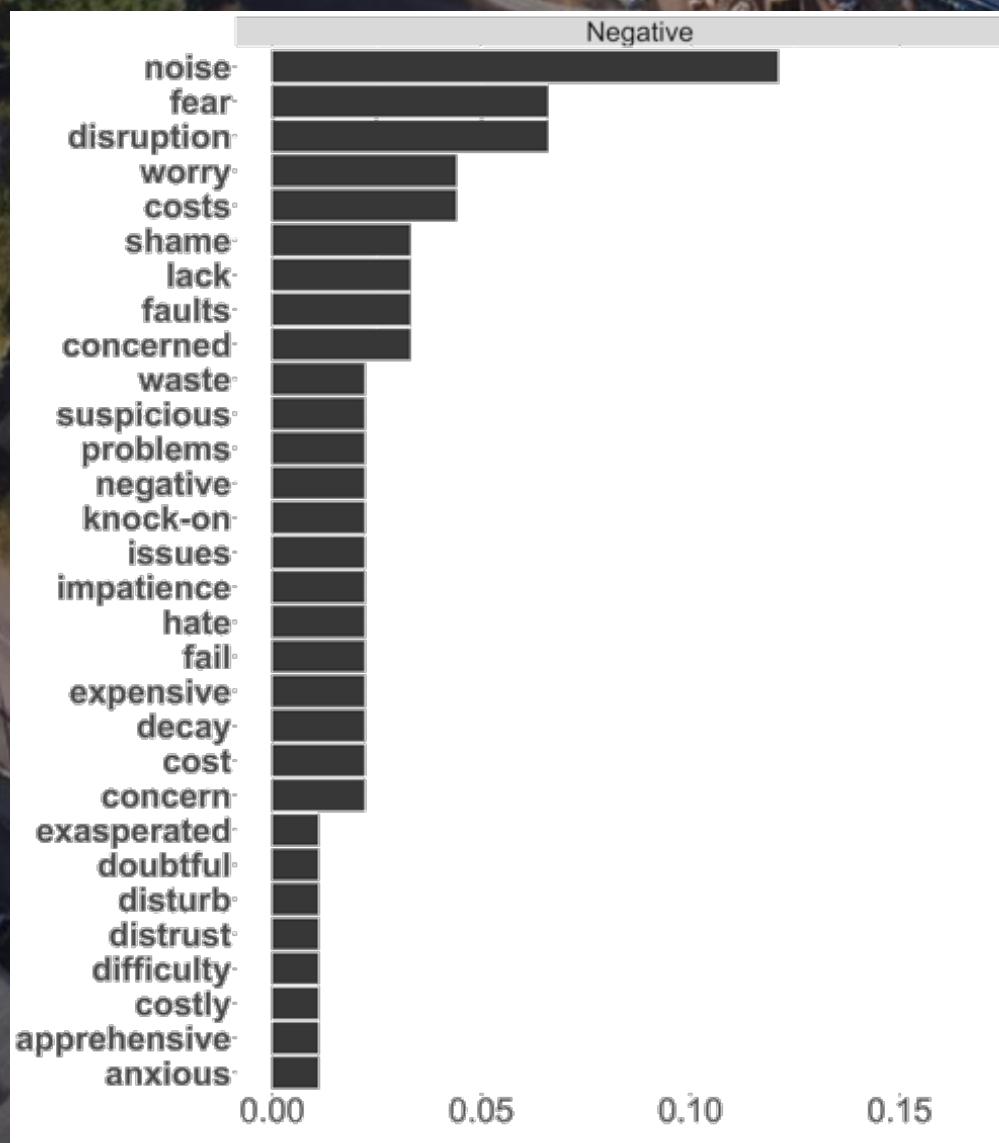




Social Site Characterisation - Mapping the Community Play



Focus Groups - Emotions and beliefs



Relative frequency of the 30 most frequent positive and negative words associated with geothermal energy.

Fairness and trust in authorities

Lisa: We're left in the dark by Cornwall Council, we don't know, do we? (FG 1)

Jessy: But I think Cornwall Council would have to do a proper consultation of it with, you know, [...] like a tick box (FG 3)

Jake: But I think it's going ahead anyway, so ... it doesn't make any difference (FG 4)

Clare: [...] I'm not sure I trust them to understand it unless they ... went and found out the information (FG 3)

Locals frequently stated that:

- more information should have been provided from the energy developers and the local council;
- they could not express their opinions during the decision-making process;
- they could have not made a significant difference anyway, even if involved.
- little confidence in which of the authorities they trust.





Symbolic meaning / cultural identity

Alexa: This takes our mining heritage to the next generation, doesn't it? (FG 3)

Sam: The interesting thing for me is that there is a huge history of innovation and you know that encompasses from the industrial revolution in mining and all the rest of it which essentially started here. And it's been carried on ever since. And that's why I like the idea of creating this technology [...] (FG 4)

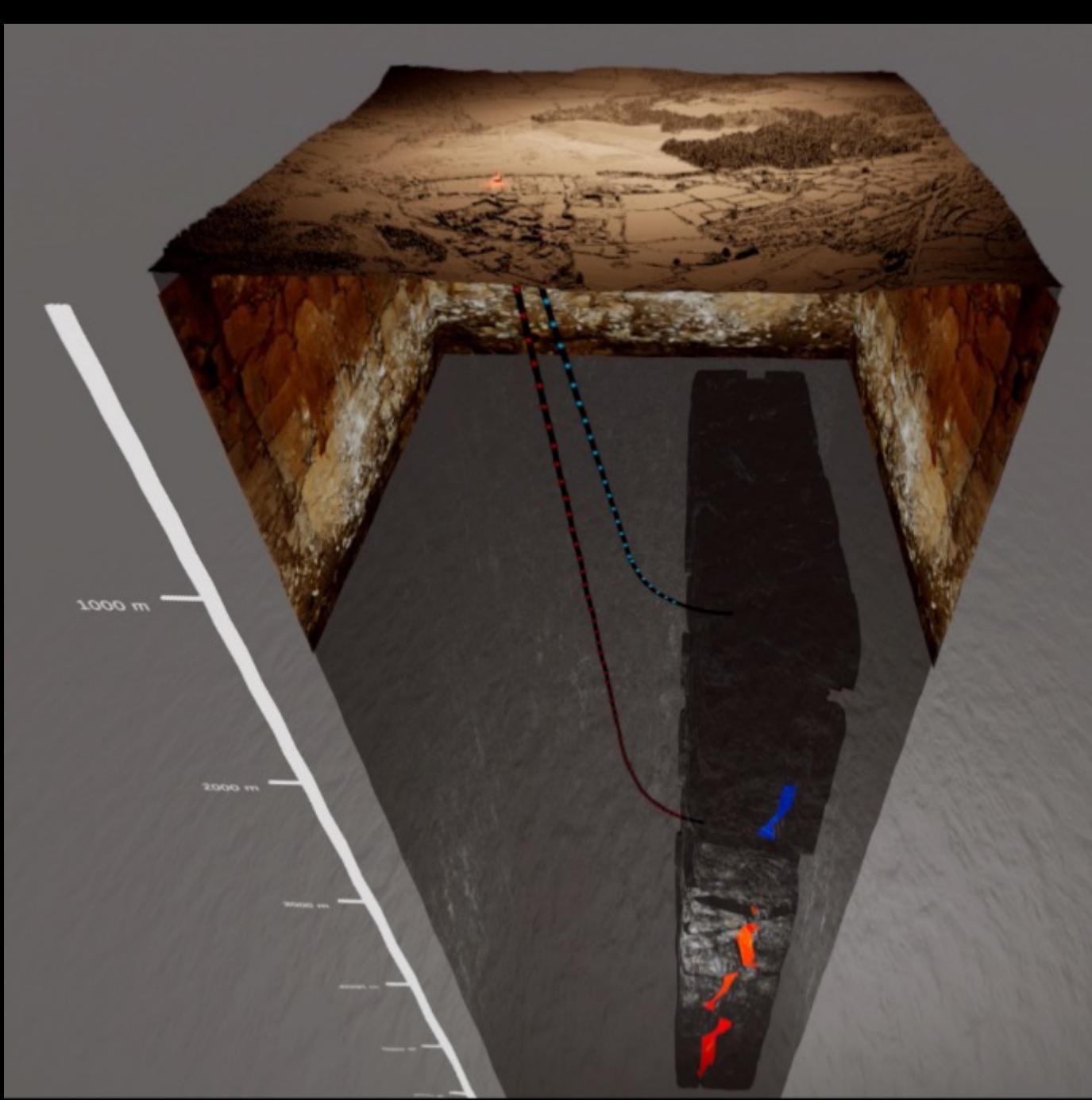
Harry: I've had nothing whatever to do with this renewable technology, other than supporting it in principle. But yeah, the community, I mean, it's a great thing for Cornwall (FG 2)

Lisa:... you're proud to be Cornish. It's not just, it's not English or British, it's Cornish (FG 1)

Engage, Educate, Entertain









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